MECHANICAL MINING IN SOME BITUMINOUS-COAL MINES

PROGRESS REPORT 8. METHODS AND EQUIPMENT USED IN UNDERGROUND DEVELOPMENT

BY J. J. SHIELDS, J. J. DOWD, AND W. A. HALEY

* * * * * * * * * * Information Circular 7813

UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary
BUREAU OF MINES
Marling J. Ankeny, Director

Work on manuscript completed January 1957. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7813."

December 1957

Generated on 2024-09-21 14:58 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

FOREWORD

This report is the eighth in a series on mechanical mining in bituminous-coal mines. Following the publication of Information Circular 7014 on Multiple-Shift Mechanical Mining in 1938, Information Circular 7067 published in 1939 and Information Circular 7178 in 1941 also discussed the same subject. Information Circulars 7223 issued in 1942, 7527 in 1949, and 7631 in 1952 dealt with the extraction of pillars with mechanized equipment. In 1954, the seventh report, Information Circular 7696 on methods of mining with continuous mining machines, was published. Reference to these reports is made in the appendix.

This report deals with methods and equipment used in underground mine development. Additional reports in the series will be published.

Generated on 2024-09-21 15:00 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

MECHANICAL MINING IN SOME BITUMINOUS-COAL MINES PROGRESS REPORT 8. METHODS AND EQUIPMENT USED IN UNDERGROUND DEVELOPMENT

by

J. J. Shields,[1] J. J. Dowd,[2] and W. A. Haley[2]

CONTENTS

	Page
Summary	1
Introduction	1
Acknowledgments	2
Procedure	2
Mine development	3
Definitions of development and production	3
Ratio of development to production	3
Factors determining amount of development needed	4
Desired output of coal per day	4
Type of mine opening	4
Presence of gas	4
System of mining	4
Types of equipment used	11
Man-shifts to develop panel	11
Man-shifts to mine panel	11
Results of study	11
Descriptions of mines studied	13
Mine 1	13
Mine 2	15
Mine 3	17
Mine 4	19
Mine 5	21
Mine 6	23
Mine 7	26
Mine 8	28
Mine 9	30

1/ Mining engineer, Bureau of Mines, Region V, Pittsburgh, Pa.
2/ Supervising mining engineer, Bureau of Mines, Region V, Pittsburgh, Pa.

Information Circular 7813

Generated on 2024-09-21 15:01 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

CONTENTS (Con.)

Page

Mine 10 33
Mine 11 35
Mine 12 37
Mine 13 39
Mine 14 42
Conclusions 44
Appendix I 45
Classification of mine employees 45
Summary of data for mines studied 52
Appendix II 66
Previous publications in the series 66

ILLUSTRATIONS

Fig.

1. Schematic plan of development from outcrop 5
2. Development of block system from outcrop 6
3. Development by room-and-pillar system from outcrop 9
4. Section of coal bed and overburden at mine 1 14
5. Method of development at mine 1 14
6. Section of coal bed and overburden at mine 2 16
7. Method of development at mine 2 16
8. Section of coal bed at mine 3 18
9. Method of development at mine 3 18
10. Section of coal bed and overburden at mine 4 20
11. Method of development at mine 4 20
12. Section of coal bed and overburden at mine 5 22
13. Method of development at mine 5 22
14. Section of coal bed and overburden at mine 6 24
15. Method of development at mine 6 24
16. Section of coal bed and overburden at mine 7 27
17. Method of development at mine 7 27
18. Sequence of cuts by continuous-mining machine at mine 7 .. 28
19. Section of coal bed at mine 8 29
20. Method of development at mine 8 29
21. Section of coal bed and overburden at mine 9 31
22. Method of development at mine 9 31
23. Section of coal bed and overburden at mine 10 34
24. Method of development at mine 10 34
25. Section of coal bed at mine 11 36
26. Method of development at mine 11 36

Generated on 2024-09-21 14:55 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
THE OHIO STATE UNIVERSITY

ILLUSTRATIONS (Con.)

Fig.		Page
27.	Section of coal bed and overburden at mine 12	38
28.	Method of development at mine 12	38
29.	Section of coal bed and overburden at mine 13	40
30.	Method of development at mine 13	40
31.	Section of coal bed and overburden at mine 14	42
32.	Method of development at mine 14	43

TABLE

1.	Summary of bed thickness, thickness mined, development data, and comparative yield from nondevelopment units...	12

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
THE OHIO STATE UNIVERSITY

SUMMARY

With the increased use of mechanized equipment in mining bituminous coal, production panels are mined out rapidly. To keep current with the rapid completion of production panels, development work must be speeded up also.

Although the same type of equipment usually is employed in development as in production places in the same mine, past output per man for development usually was less than from production panels. A study of development practices in 14 mines reveals a tendency toward equalization of the output per man between development and production.

INTRODUCTION

The study of methods and equipment used in underground bituminous-coal-mine development was undertaken to determine how the application of modern methods and equipment affect the rate of entry development.

In this automation era, an industry that does not remain alert and improve its methods and practices may lose the market for its product. The coal industry has been accused of being slow to adopt modern mining methods, but nothing is farther from the truth. This industry is continually trying new methods and equipment to produce more coal for less money and thereby permit wider use of its product. Underground mining is beset with problems that would be considered unsurmountable in many surface operations; when solved at each individual mine, they become part of the normal operation at that mine.

Coal still is a basic industrial fuel of the Nation and is relied upon to meet highly competitive and fluctuating demands. In this respect, the producers have done a remarkable job, especially when it is considered that these fluctuations have not always been gradual. Coal mines cannot be kept economically on a standby basis and be ready to produce intermittently at maximum rate. A mine can be planned to yield a given daily production and, as many have been forced to do, can be operated for a limited time at less than the planned rate. However, if the production rate of a mine is reduced severely or if reduced for a long period, the operation may become too costly and have to be abandoned. Once a mine is abandoned, it is seldom reopened and put back into operation; consequently, the production potential of an abandoned mine is eliminated from future planning. Should the demand for coal then increase or an emergency occur during which greater production is needed, the mines still in operation would be expected to yield the additional fuel. If existing mines could not produce the needed increase, new mines would be opened to supply the increased demand. Even though most coal companies usually have a plan, complete in all details, for a new mine, only a few new mines are opened each year. New mines are not only expensive to open and to develop to capacity, but such work requires time. Therefore, unless an increased demand for coal is indicated to be more than temporary, the demand may be over before the new mine could be developed for production.

Generated on 2024-09-21 14:53 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

This report deals with the methods and equipment used in underground mine development as differentiated from those used in production. It is the eighth in a series of publications that describe the methods and practices used in mining bituminous coal mechanically. A list of previous publications is given in appendix II.

ACKNOWLEDGMENTS

The Mining and Preparation Section of the Branch of Bituminous Coal thanks the officials of the coal-mining companies for cooperation in permitting this study to be made in their mines and for the courtesies extended to the Bureau engineers assigned to the job. The suggestions and comments of mine officials who reviewed the individual mine reports and who granted permission to the Bureau to publish the information contained in those reports are appreciated.

The assistance of Malcolm O. Magnuson, Jr., and John C. Bobella, formerly with the Mining and Preparation Section, who assisted in the field studies, is acknowledged.

PROCEDURE

The plan of the study was explained to officials of mines in which it was proposed that studies be made. If these officials gave permission to have a study at their mine, the Bureau engineer assigned to the job obtained general information from them for use in describing the mine operation.

A map was requested; if not available, a suitable sketch from the posted mine map was made of the development section to be studied.

By underground examination the location of each working face in the development group was determined and shown on the map. The underground workings were measured for comparison with those shown on the map. The mining plan, cycle of operation, the units and types of equipment being used, and all phases of the work were observed. The duties of each full- and part-time crew member of the development unit were observed and recorded.

The mining plan was drawn to show how the unit being studied was operated. The coal bed was measured to get its average thickness in the area; from this average measurement a bed section was sketched to show partings and the portions of the bed mined, if the full bed thickness was not mined. If available, details of the complete overburden section were obtained. During this phase of the study a record was kept of the number of man-shifts worked, the number of tons produced, and the advance in each working place.

As it was impossible in the allotted period to spend a long time at any mine for gathering extensive data to establish operating averages, the mine officials were requested to keep an accurate record over a 6- to 8-week period of the man-shifts worked and the tons produced from the specific section of the mine. After this period elapsed, the mine was revisited, and the advance in each working place was entered on the map. From the total advance of the workings, the number of man-shifts worked, and the tons of coal produced during the entire investigation period, comparisons could be made with work in production areas in the mine.

On conclusion of the work at each mine, a report was prepared covering the entire study at that mine. The report was submitted to the mine operator for comments and his approval for publication of the data by the Bureau.

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

MINE DEVELOPMENT

Definitions of Development and Production

In coal mining there are two broad classes of underground openings: (1) Those made for mine development and (2) those made for production. The development work comprises driving entries, entry crosscuts, room necks, or other openings necessary to make production places from which most of the coal will be produced later.

All development openings formerly were driven narrower than production places, and the term "narrow" was used synonymously with "development." Only a few men could work as a group in development headings, because the places usually were so narrow and were driven in sets of 2 and 3. The rate of progress therefore was slow, and the cost of development coal was high.

As the mines became more mechanized and yielded larger quantities of coal at a faster rate per shift, it became necessary to increase the quantity of ventilating air. If the customary 2 or 3 headings could not be driven wider, the number of headings had to be increased. This procedure, in turn, permitted the use of more workmen in the development group, as well as a larger concentration of faces to get more effective use of the mechanical equipment. It is common practice now to drive development headings up to 10 to 12 in a group; in many instances the headings are driven wider than heretofore. As the width of the development heading approaches that of the production place, the productivity from development more nearly equals that from the production places.

In contrast with development places are those for production. In the room-and-pillar system the production places are rooms in the panels and all pillars that are mined on retreat. In the block system the blocks mined on retreat would be considered the production working places, and in a longwall system they are the long faces being advanced or retreated.

According to the definition of "development" and "production" as used in this report to describe working places, it is assumed that development is primarily the driving of main, cross, and panel entries (together with crosscuts) necessary to form production panels. Even though the yield of coal from each type place is equal, development must precede formation of a production place.

Ratio of Development to Production

For successful operation of a mine the relationship between development and production at the mine should be determined. The "rate of development" as used in this report is considered to be the rate of bed penetration (feet of openings driven), although, strictly speaking, the production area developed by a given footage driven is a factor. This relationship could be called the development-production ratio and from it can be determined the rate of development necessary to permit continued production at a given rate. If development does not exceed production at the rate represented by the development-production ratio, mining in a production section could be completed before the next production section is ready for operation. This may cause a reduction in the daily mine yield if there is a difference in rate of yield between development and production places. In mines where the cost of coal mined in development is more than that from production sections, such imbalance between development and production would increase the overall cost of the mined coal.

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

It is apparent that different ratios of development to production must be used for new mines compared with old ones; for mines with shaft openings as compared with those opened by drift; for mines using room-and-pillar method mining as opposed to the block system or the longwall system; for mines in which pillars are recovered in mining compared with those in which pillars are not recovered; and for mining in thick coal beds as against mining in thin beds.

Factors Determining Amount of Development Needed

In the study it was found that there were many variables on which the development-production ratio depends, and the influence of several of the more important factors are discussed.

Desired Output of Coal Per Day

One of the first decisions to make is to determine what total output of coal is desired from the mine per day. This factor probably is influenced by the seasonal demand. If the cost of development coal is comparable with that from production, a light demand could mean that all of the yield might be from developing new panels in preparation for heavier demand when more production places would be needed. If the costs of development coal are higher than of production coal, the supply for even a light demand should be furnished in accordance with the development-production ratio.

Type of Mine Opening

Perhaps the type of mine opening does not have too much influence on the development-production ratio, but it does affect the rate at which development can proceed to make production places. This is true, especially with new mines. If the mine is a shaft, development can proceed in two or more directions, depending on the plan of the mine bottom. If the mine is opened by drift it may be necessary to advance drifts in one direction only for a long distance before lateral entries can be started. With older mines the type of opening is not so important, because development places can be started simultaneously from many locations.

Presence of Gas

Whether or not a mine is gassy will influence on the amount of development needed to make production panels. If there are too few entries in a development group to permit travel of an adequate amount of air to dilute and disperse mine gas, additional development entries will have to be driven. Or, it may be possible to enlarge the cross-section area of each entry to get the added area for increasing the air supply; but either way, the amount of development would be increased over that needed if the mine is not gassy.

System of Mining

One of the most important factors that determine the amount of development needed to keep the operation in balance is the system of mining used. To demonstrate the possible effect of the plan of mining on the development-production ratio, two plans of mining an area will be compared. Figure 1 shows the general plan schematically. Each mining plan begins at the bed outcrop; and working panels are developed by multiple main and cross entries, the panels being turned off both sides of the cross mains.

Generated on 2024-09-21 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

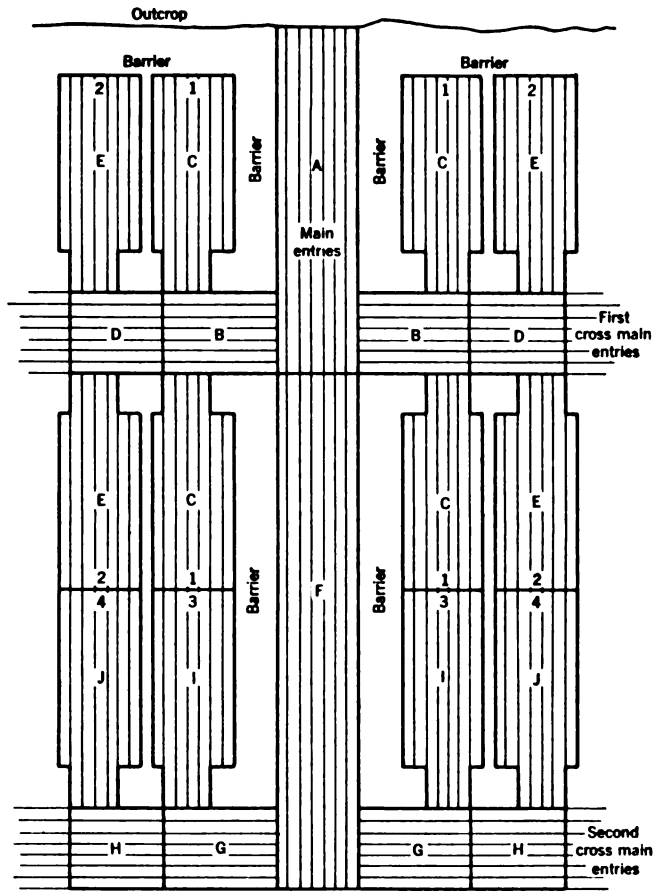

Figure 1. - Schematic plan of development from outcrop.

The development is indicated by letters A to J, and the production units resulting from the development are indicated by numerals. For example, it will be seen that, by driving entries in sections A and B, the first cross mains will be advanced far enough to start development C in four places which, when completed, will make 4 production panels (4 panels marked 1 in fig. 1). Four additional panels (shown as 2 in fig. 1), off the first cross mains, can be developed by driving development D and E. To get production panels off the second cross mains, it would be necessary to develop F, G, and I, following the same pattern as in developing panels off the first cross mains.

Figure 2 is the plan of a mine to be mined by the block system with the blocks to be recovered on retreat. In this plan main and cross main entries 16 feet wide are driven in groups of 8 on 45-foot centers. All crosscuts are 16 feet wide on 80-foot centers. It is assumed that the coal bed mined is 84 inches thick.

A development crew similar to that observed at one of the mines studied will be assumed to comprise the following workmen:

Classification	Number of men	Classification	Number of men
Foreman	1	Shot firer	1
Loading-machine operators	2	Shuttle-car operators	3
Loading-machine operators' helpers	2	Roof bolters	4
Cutting-machine operators	2	Mechanic	1
Cutting-machine operators' helpers	2	Boom man	1
		Total	19

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

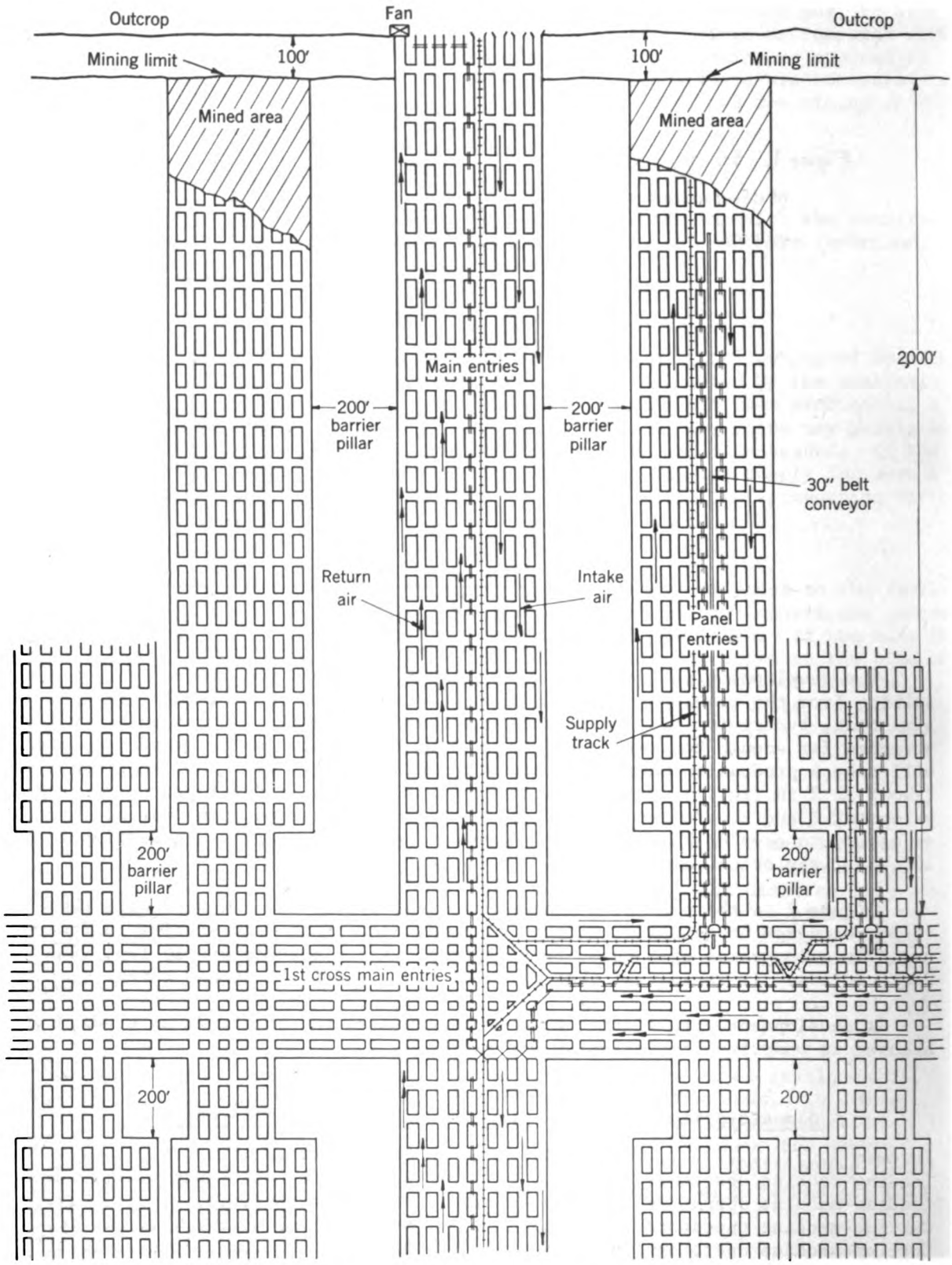

Figure 2. - Development of block system from outcrop.

Generated on 2024-09-21 14:54 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

This group will work as a team, and individual workers will be used interchangeably for any work to be done.

Mining equipment of the same type and amount as used at a mine studied is proposed for this plan as follows:

3 mobile-loading machines (1 to be kept in reserve as a spare).
2 universal cutting machines.
2 roof-bolting machines.
2 hydraulic coal drills mounted on roof-bolting or cutting machines.
3 shuttle cars.
1 rock-dusting machine.
1 30-inch belt conveyor.
1 supply track.
1 car hoist.

Before any of the blocks (production places) are ready for retreat mining, the entries and crosscuts in development sections A, B, and C must be completed. The total development work necessary to complete four production panels (marked 1 in fig. 1) therefore is:

Development section	Feet in unit			Number of units	Grand total, feet
	Entry	Crosscut	Total		
A	19,280	6,786	26,066	1	26,066
B	3,920	1,653	5,573	2	11,146
C	15,400	4,814	20,214	4	80,856
Total ...	38,600	13,253	51,853		118,068

While these 4 production panels are being retreated, additional development work should be in progress, so that when the 4 panels (shown as 1 in fig. 1) are completed, 4 additional panels (shown as 2 in fig. 1) will be completely developed. To accomplish this, the development in D and E must be completed as follows:

Development section	Feet in unit			Number of units	Grand total, feet
	Entry	Crosscut	Total		
D	2,880	1,450	4,330	2	8,660
E	15,400	4,814	20,214	4	80,856
Total ...	18,280	6,264	24,544		89,516

The plan of mining, the number of men in the crew, the type of equipment, and the amount of equipment are the same as those used in one of the mines studied. At that mine the average advance in the group of entries (and the required crosscuts) was 171 feet per shift or 21.4 feet of development per entry per shift. At this rate of mining, it would require 691 work shifts of the unit crew to complete the 118,068 feet of development necessary for preparing 4 production panels for operation. To develop the next 4 production panels and each succeeding group on the same cross mains would require driving 89,516 feet of development work; at the rate of 171 feet per unit shift, this would require 524 unit shifts.

Development required to complete the first group of 4 production panels off the second cross mains would be F, G, and I, or a total of 138,140 feet. At the rate of 171 feet advance per shift, the development would require 808 unit shifts. For each succeeding group of 4 production panels on the second cross mains, the development would require 89,516 feet of development or 524 unit shifts of work.

Generated on 2024-09-21 14:55 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Thus, if a new mine is developed in accordance with the plan shown in figure 2, the following development would be required:

	Feet	Unit shifts
First set of 4 production places off first cross mains	118,068	691
First set of 4 production places off second cross mains	138,140	808
Each succeeding set of 4 places off either first or second cross mains	89,516	524

For comparison, development of a room-and-pillar method of mining in thin coal beds has been calculated, using the same schematic plan. This plan is shown in figure 3.

Main and cross entries 25 feet wide are driven in groups of 6 on 50-foot centers. All entry crosscuts are 20 feet wide on 80-foot centers in the mains.

Panel entries 25 feet wide and on 50-foot centers are driven off the cross mains in groups of 4. Leaving barrier pillars 200 feet wide to protect the main and cross main entries, rooms 40 feet wide on 55-foot centers are turned off the outside panel entries and driven 275 feet deep, with crosscuts 30 feet wide on 69-foot centers. It is assumed that the coal bed is 36 inches thick and that the entries are advanced in pairs a predetermined length, after which the succeeding pair in the panel or each succeeding pair in the mains and cross mains is advanced. Production mining will be done by driving rooms in pairs advancing on one side of the panel and retreating on the opposite side.

A development crew similar to that used at one of the mines studied will be assumed and comprises the following men:

Classification	Number of men	Classification	Number of men
Section foreman	1	Conveyor man	1
Loading-machine operator	1	Timberman	1
Loading-machine operator's helper	1	Supply man	1
Cutting-machine operator	1	Mechanic	1
Cutting-machine operator's helper	1	Boom man	1
		Total	10

This group of men will work as a team, and individual workers will be used interchangeably for any work to be done.

The following mining equipment would be needed for this plan:

1 loading machine.
2 piggyback conveyors.
2 shortwall cutting machines.
2 chain conveyors.
1 mother chain conveyor.
1 elevating conveyor.
2 handheld electric drills.
1 roof-bolting machine.
1 supply track.
1 car spotter.

Generated on 2024-09-21 14:50 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

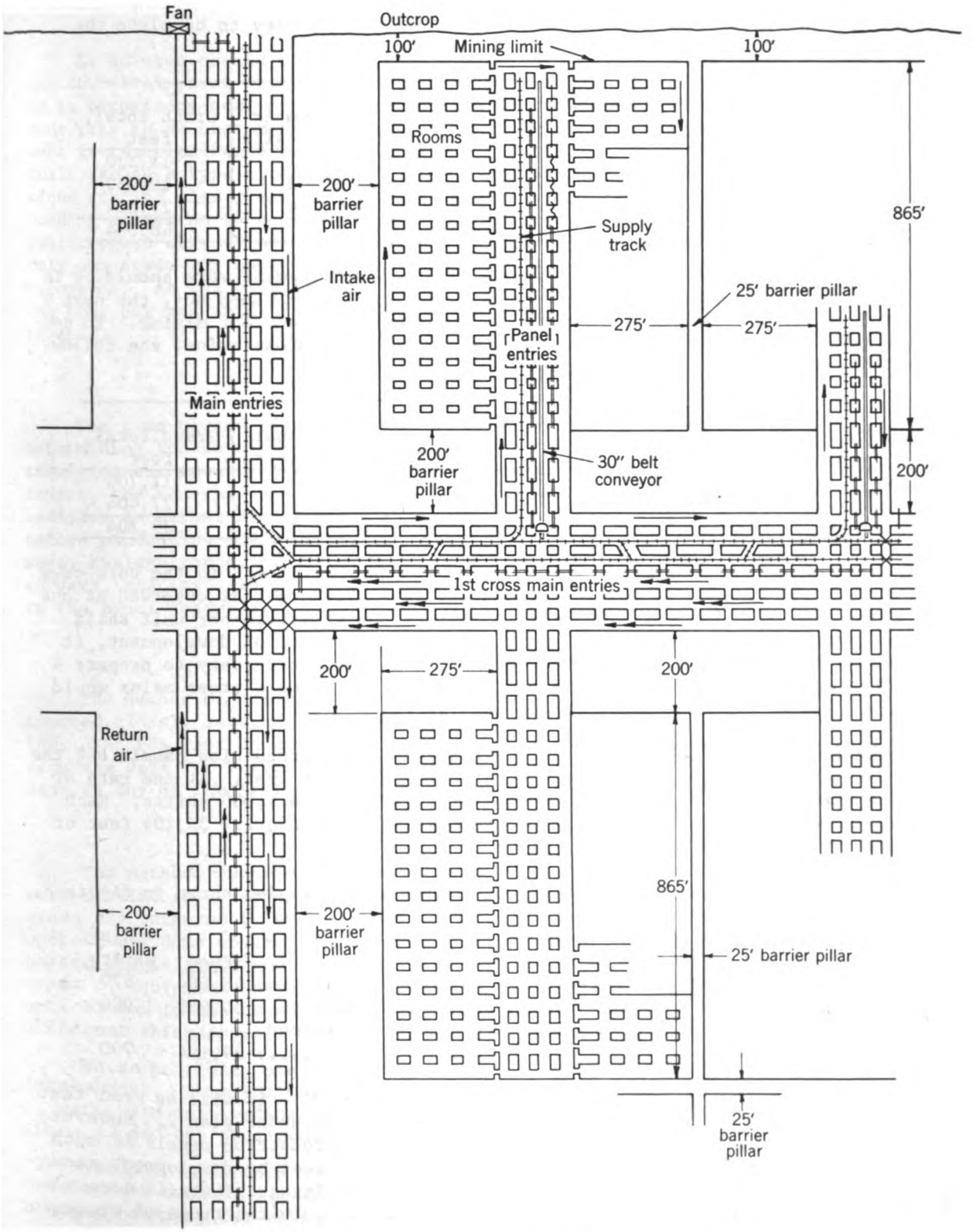

Figure 3. - Development by room-and-pillar system from outcrop.

Generated on 2024-09-21 14:50 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

In this plan of development the following work is necessary to complete the first four production panels (shown as 1 in fig. 1):

Development section	Feet in unit				Number of units	Grand total, feet
	Entry	Crosscut	Room necks	Total		
A	8,730	2,500	-	11,230	1	11,230
B	3,900	1,125	-	5,025	2	10,050
C	4,350	1,425	1,076	6,851	4	27,404
Total	16,980	5,050	1,076	23,106		48,684

While these 4 panels are being mined, additional development work should be in progress so that when the 4 panels (shown as 1 in fig. 1) are mined out, the next 4 (shown as 2 in fig. 1) should be completely developed and ready for mining. To complete the next 4 panels and each succeeding 4 off the same cross mains, the following development in D and E must be completed:

Development section	Feet in unit				Number of units	Grand total, feet
	Entry	Crosscut	Room necks	Total		
D	4,500	1,350	-	5,850	2	11,700
E	4,350	1,425	1,076	6,851	4	27,404
Total	8,850	2,775	1,076	12,701		39,104

The plan of mining described, together with the number of men in the unit crew and using the same type and amount of equipment, is similar to that observed at one of the mines studied. The total advance in entries and crosscuts per unit shift using the described plan would be about 56 feet. At this rate of development, it would require 870 shifts for the 48,684 feet of development necessary to prepare 4 panels for production. To develop the next 4 panels on the same cross mains would require 39,104 feet of development or 700 unit shifts of work.

Development required to complete the first group of 4 production panels off the second cross mains would be F, G, and H or a total of 55,939 feet. At the rate of 56 feet advance per unit shift, the development would require 1,000 shifts. Each succeeding group of panels off the second cross mains would require 39,104 feet of development or 700 shifts of work.

Thus, if a new mine is developed in accordance with the plan shown in figure 3, the following development is required:

	Feet	Unit shifts
First set of 4 production places off first cross mains	48,684	870
First set of 4 production places off second cross mains ...	55,939	1,000
Each succeeding set of 4 places off either first or second cross mains	39,104	700

Comparing this development with that for plan 1 (fig. 2), it will be seen that many more feet of development is required under plan 1 than under plan 2. However, the total number of unit shifts required to develop four production panels is much less under plan 1. Not all of the difference between the feet of development necessary for each plan is caused by the different systems of mining. There is a vast difference in the thickness of the coal bed and, therefore, in the types of equipment used.

Generated on 2024-09-21 15:00 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Types of Equipment Used

As pointed out in comparing two systems of mining, an important factor affecting the development-production ratio is the size and type of equipment used. More so in bituminous-coal mining than in most any other business, the operation at each mine gets to be custom-made. In many mines the type of equipment used for development is identical with that used for production. Too frequently, a mining method is built around a type of equipment, simply because the equipment is on hand. The mines studied show great variation in types of equipment used, ranging from hand-loading equipment to continuous-mining machines. Because a report in this series of publications already has been published on methods using continuous-mining machines, only one study was made at a mine where a continuous-mining machine was used in development. As was expected and based on the results of the continuous-mining study, the tons per man-shift in development was higher at this mine than at other mines studied.

Man-Shifts to Develop Panel

The time needed to get a panel completed for mining is an important factor in determining the development-production ratio. By means of the process used in determining the amount of development for each plan of mining previously given in this report, the man-shifts necessary to mine the development coal can be estimated. In addition to actual mining of the coal in development, other operations are essential before production can be started. These items include brushing (if needed for manways, haulage roads, or aircourses), making connections with permanent powerlines and airways, and installation of pumping, ventilating, and power accessories where needed in the panel roadways.

Man-Shifts to Mine Panel

The number of man-shifts needed to mine a production panel completely can be estimated closely enough to determine how soon the next panel should be ready for mining. Records kept on each production panel as mining progresses will provide more accurate data for future planning, because such records would reflect any changes made in any of the factors that affect the rate of production.

RESULTS OF STUDY

The methods and equipment used in developing underground bituminous-coal mines were studied at 14 mines in West Virginia, Pennsylvania, Kentucky, and Ohio. These mines are referred to by a number only in this report and were selected to obtain operational data on the various types of equipment and the mining methods used. Expected diversifications in methods and equipment were found in the studies. Some types of equipment were used in several different methods of mining; with varied numbers of men in the crew with different numbers of entries in a group; and in beds of different thicknesses.

Where possible, production data were obtained also for comparison with those for development. This was not always possible, because the production units, as at mine 9, were used for loading rock, and the time for each work was not kept separately. At mines 13 and 14, development work only was in progress.

Table 1 summarizes for the 14 mines data giving bed thickness, mining thickness, development data, and comparative yield from production places at some mines. A more complete summary for each mine and the classification of all employees at each mine are given in appendix I.

Generated on 2024-09-21 14:53 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

TABLE 1. - Summary of bed thickness, thickness mined, development data, and comparative yield from nondevelopment units

Mine	Method of loading[1/]	Thickness of bed, inches	Thickness of bed mined, inches	Average width of development entries, feet	Number of entries in a set	Number of employees in development unit crew	Average yield from development per unit crew man per shift, tons	Average yield from production per unit crew man per shift, tons	Average advance of set of development entries per shift, including crosscuts, feet[2/]	Average advance of set of development entries per shift, feet[2/]
1	M	35	35	30	4	9	16.7	26.1	14.0	10.8
2	H	36	36	14 and 20	6	9	10.9	15.1	7.3	6.1
3	H	40	40	24	6	12-1/2	12.5	14.5	8.2	5.4
4	M	42	42	20	3	11-1/4	10.4	9.8	14.4	10.2
5	H	75	43	15	3	8-1/2	13.5	13.5	6.4	5.0
6	M	46	46	15 and 17	4	12	25.3	30.9	28.4	22.0
7	C	46	46	27	9	7	42.8	42.3	8.7	6.1
8	M	73	55	20	6	12	42.5	43.5	23.3	18.2
9	M	59	59	18 and 20	5	10-1/4 and 5	14.2	-	8.6	6.1
10	M	65	65 and 41	25 and 27	6	12	39.0	36.7	12.4	8.9
11	M	85	73	14	5	13	26.4	38.6	20.8	13.2
12	M	80	80	12 and 14	7	13	20.7	26.5	10.4	7.0
13	M	96	84	16	8	19	39.4	-	21.3	16.2
14	M	96	84	16	10	21	42.4	-	17.1	13.3

1/ M = mobile-loading equipment; H = hand loading; and C = continuous mining.
2/ Total feet of advance is obtained by multiplying by number of entries in a set.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

At mines 2, 3, and 5 the development work studied employed hand-loading methods. A continuous-mining machine was used for the work at mine 7. At all others mobile-loading equipment was in use. No simple comparison between mines can be made either on tons per man-shift from development basis or on number of feet of advance per shift, even when similar equipment is used. However, for the 3 mines using hand-loading methods, the yield per unit crewman per shift ranged from 10.9 to 13.5 tons and averaged 12.3. At the 10 mines where mobile-loading equipment was used the yield ranged from 10.4 to 42.5 tons per man-shift and averaged 27.7 tons. The yield at the one mine using continuous-mining machines was 42.8 tons per man-shift. Although it is unwise to form conclusions based on the results from studies at only 14 mines, at least a definite trend is shown. The difference in output per man-shift between development and production decreases as the degree of mechanization used in development increases. At mines 4, 7, and 10 the output per man-shift was greater in development than in production.

DESCRIPTIONS OF MINES STUDIED

Each mine studied is described so that details are available for comparisons. These data can be used in formulating a plan of mining for types of equipment most suitable for underground coal-mine development under selected conditions. A classification of employees at each mine, as well as a summary of operation for the mine, are given in appendix I.

Mine 1

This mine is operated in the No. 3 Elkhorn bed, which averages 35 inches thick in this area. (See fig. 4.) The bed is flat lying, with some local dips. The coal is underlain by fire clay and overlain by a sandy shale that usually provides good roof. The overburden averages 315 feet thick and consists mainly of strata of shales and sandstones.

The mine is operated 2 shifts a day and produces an average of 1,070 tons of raw coal (1,049 tons of clean coal), using the following units:

2 mobile-loading piggyback to chain-conveyor units developing panel entries; 9 men each.
1 mobile-loading piggyback to chain-conveyor unit mining rooms; 9 men.

A detailed study was made of one entry development unit only. Entries 30 feet wide are driven in sets of 4 on 52- and 68-foot centers, with crosscuts 20 feet wide on 68-foot centers. (See fig. 5.) Entries are developed by a unit consisting of 9 men, 1 mobile-loading machine, 2 piggyback conveyors, 2 shortwall cutting machines, 2 chain conveyors (in entries), 1 mother chain conveyor, 1 elevating conveyor, 2 handheld electric drills, 1 roof-bolting machine, 1 supply truck, and 1 car hoist.

The cycle of operation is: Timber, drill and cut, extend conveyor, blast, and load coal. Power to operate the mining equipment is furnished at 250 volts d.c.

Entries are advanced in pairs, with a 38-foot coal pillar between each. The first pair (entries 1 and 2) is advanced 340 feet. Equipment then is moved out and set up in entries 3 and 4. While these entries are being advanced, the bottom is brushed, the main-line track is extended in number 1 and 2 entries, and a new loading station is established 320 feet ahead of the old station. When the entries 3 and 4 are advanced 340 feet, the equipment is moved back through the last open

Generated on 2024-09-21 14:53 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:57 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

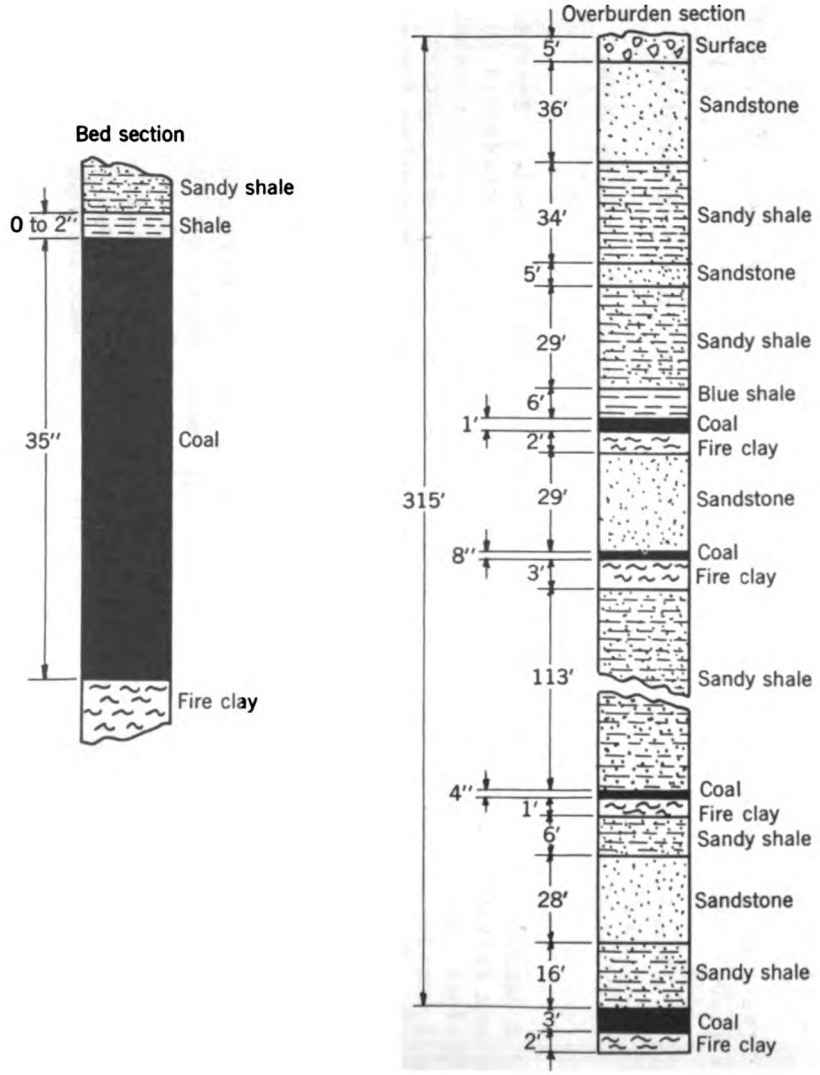

Figure 4. - Section of coal bed and overburden at mine 1.

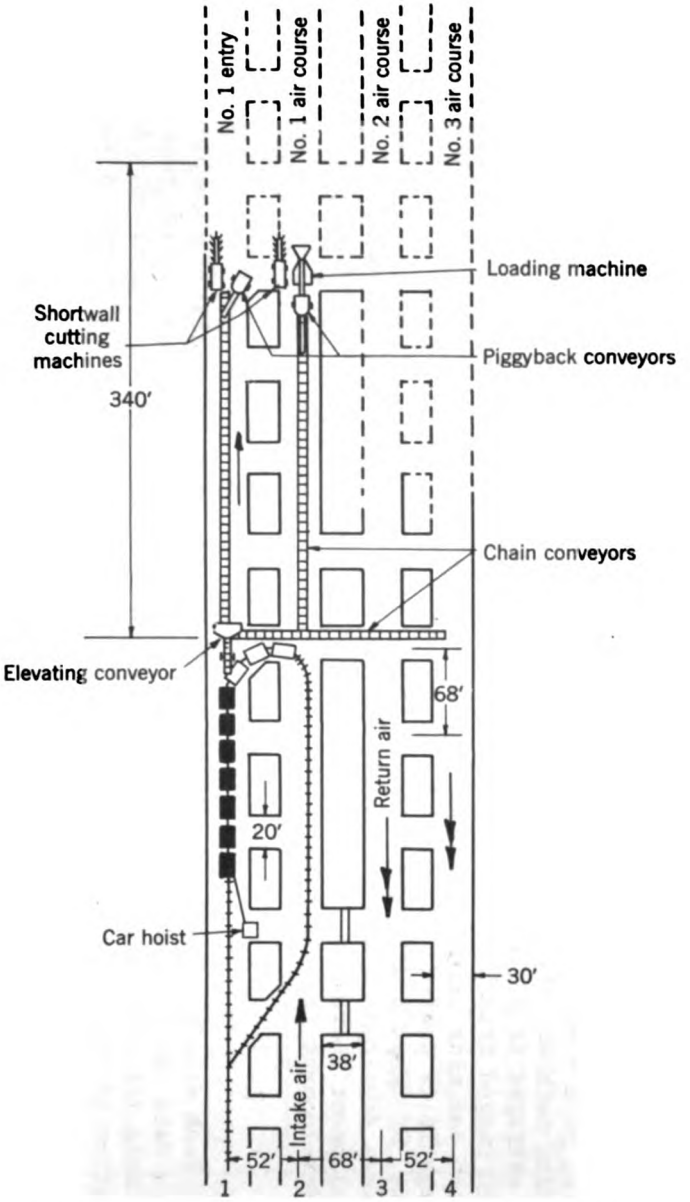

Figure 5. - Method of development at mine 1.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

crosscut to entries 1 and 2, and the same cycle is repeated. Three rows of props on each side of the chain conveyors, spaced 4 and 5 feet apart, support the roof. Roof bolting is done when required with 3/4-inch expansion shell-type bolts 2 feet long set against 6- by 6- by 3/16-inch steel bearing plates. The bolts are set on 5-foot centers.

Five equally spaced holes 9 feet long are drilled 1 foot below the roof. The coal is bottom-cut, and the conveyor is extended. Each of the holes drilled in the coal is charged with four sticks of permissible explosives; they are blasted one at a time.

The coal is loaded through a piggyback conveyor, transferred to a chain conveyor, and discharged into 2-1/2-ton-capacity, steel, bottom-dump mine cars. The loaded cars are transported to the surface by a 15-ton trolley locomotive.

Main-line haulage track is 60-pound rail laid on 42-inch gage. Panel haulage track is 40-pound rail laid to the same gage.

Rock dusting is done by hand on shift and by machine on weekends, when required.

A unit crew consists of the following men:

Section foreman	1
Loading-machine operator	1
Loading-machine operator's helper	1
Cutting-machine operator	1
Cutting-machine operator's helper	1
Conveyor man	1
Timberman	1
Utility or supply man	1
Boom man	1
Total	9

A unit crew produces an average of 150 tons of raw coal per shift, or 16.7 tons per man-shift. The average advance in each entry in a development group is 10 feet per shift, a total of 20 feet for the group.

Mine 2

This mine is operated in both the Pocahontas No. 4 and the Pocahontas No. 3 coal beds. A detailed study was made of development in the No. 3 bed, which averages 36 inches in thickness in this area. (See fig. 6.) The bed is flat lying, with a few horsebacks or local rolls. A bone-coal parting 4 inches thick occurs 22 inches above the bottom of the bed. The coal is underlain by a firm, clayey shale and overlain by 2 feet of shale, above which is a sandstone 145 feet thick. The overburden ranges from 350 to 960 feet in thickness and consists of shales, sandstones, and a few coal beds.

The mine is operated 1 shift daily in the No. 3 bed, from which an average of 98 tons of raw coal (87 tons of clean coal) is produced, and 2 shifts daily in the No. 4 coal bed, from which an average of 1,412 tons of raw coal (1,257 tons of clean coal) is produced.

Generated on 2024-09-21 14:59 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:58 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

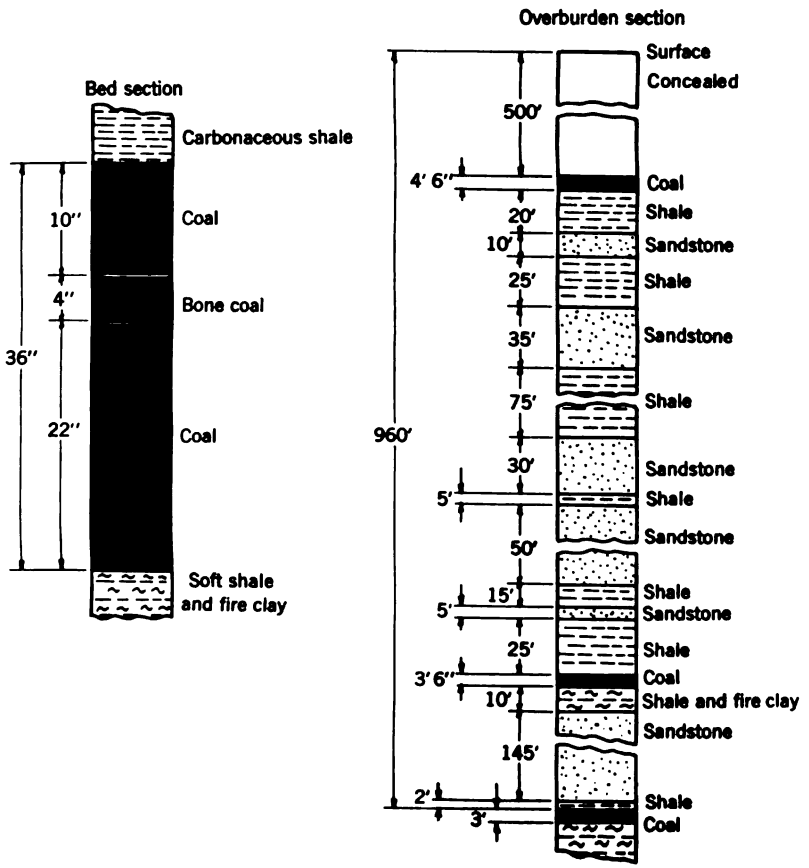

Figure 6. - Section of coal bed and overburden at mine 2.

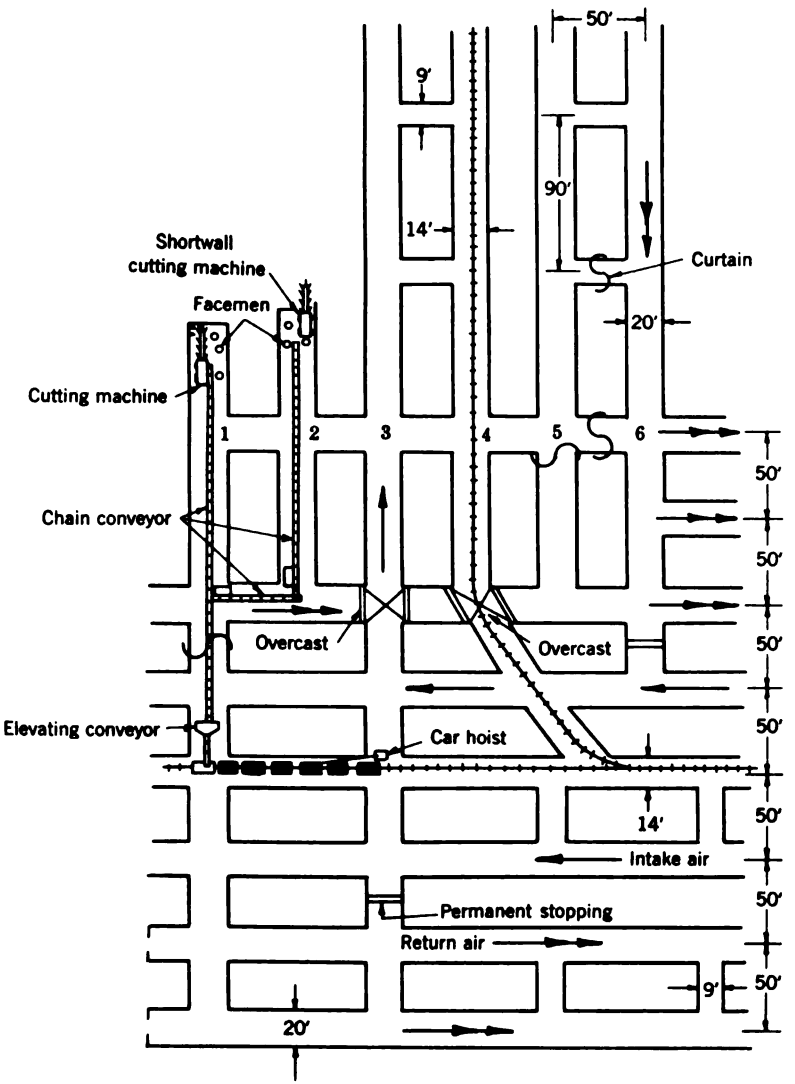

Figure 7. - Method of development at mine 2.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The following units are used:

1 unit, hand-loading onto chain conveyors, developing main entries; 9 facemen (No. 3 bed).
2 units, hand-loading onto chain conveyors, mining rooms; 12 facemen each (No. 4 bed).
1 duckbill unit in room mining; 9 facemen (No. 4 bed).
2 units, mobile-loading, chain conveyor, developing entries and mining rooms; 15 facemen each (No. 4 bed).

A detailed study was made of the 9-man main-entry development unit. Main entries 14 and 20 feet wide are driven in sets of 6 on 50-foot centers, with crosscuts 9 feet wide on 90-foot centers. (See fig. 7.) The haulage entry (No. 4 in fig. 7) is driven 14 feet wide and top-brushed to 6 feet above the rail. The entries are advanced in pairs for 300 feet. These entries are developed by a unit consisting of 9 men, 2 shortwall cutting machines, 2 handheld electric drills, 3 chain conveyors, 1 elevating conveyor, and a car hoist. Power to operate the equipment is furnished at 250 volts d.c.

The cycle of operation is: Timber, drill, cut, blast, and load coal. Four rows of props on 4-foot centers are set in each entry. Four holes are drilled below the bone parting, 1 on each rib and 2 near the center of the entry. The entry then is undercut with a shortwall cutting machine. A charge of 2 to 4 sticks of permissible explosive in each hole is used to break the coal. The facemen handload the coal onto the chain conveyors; it is transported by the mother conveyor and an elevating conveyor to 3.2-ton-capacity steel mine cars. Loaded trips of 8 to 10 cars are transported by a 15-ton locomotive to the rotary dump at the slope bottom. A 42-inch belt conveyor transports the coal mined from both coal beds through a 19° slope to the surface.

A crew of 3 men on each of 2 shifts top brushes, bolts the roof, and lays track (60-pound) in No. 4 entry. Wedge-type bolts, 1-inch diameter by 42 or 48 inches long, are set against 6- by 6- by 3/8-inch steel bearing plates. Bolts are set 3 feet from the ribs and 4 feet apart.

Rock dusting is done by hand casting on shift and by machine off shift.

A unit crew consists of 9 men - 6 men to timber, drill, cut, blast, and load the coal in the entries; 1 foreman, 1 supply man, and 1 boom man. This unit crew produces an average of 98 tons of raw coal per shift, or 10.9 tons per man-shift. The average advance in each entry in a development group is 6.1 feet per shift, a total of 36.5 feet for the group.

Mine 3

This mine is operated in the Pocahontas No. 3 coal bed, which averages 40 inches in thickness in this area. (See fig. 8.) The bed is flat lying, with few minor rolls or disturbances. A bone-coal parting occurs 29 inches above the bottom of the coal bed. The coal is underlain by a firm shale and overlain by 3 to 8 inches of draw slate that is taken down during mining and gobbed in working places. The overburden averages 435 feet in thickness and consists of shales and sandstones.

The mine is operated 2 shifts daily and produces an average of 963 tons of raw coal (819 tons of clean coal), using the following units:

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

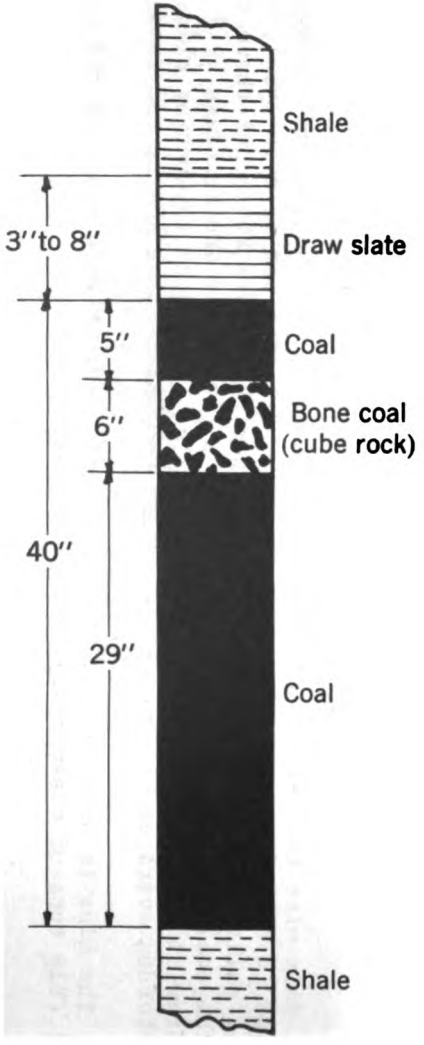

Figure 8. - Section of coal bed at mine 3.

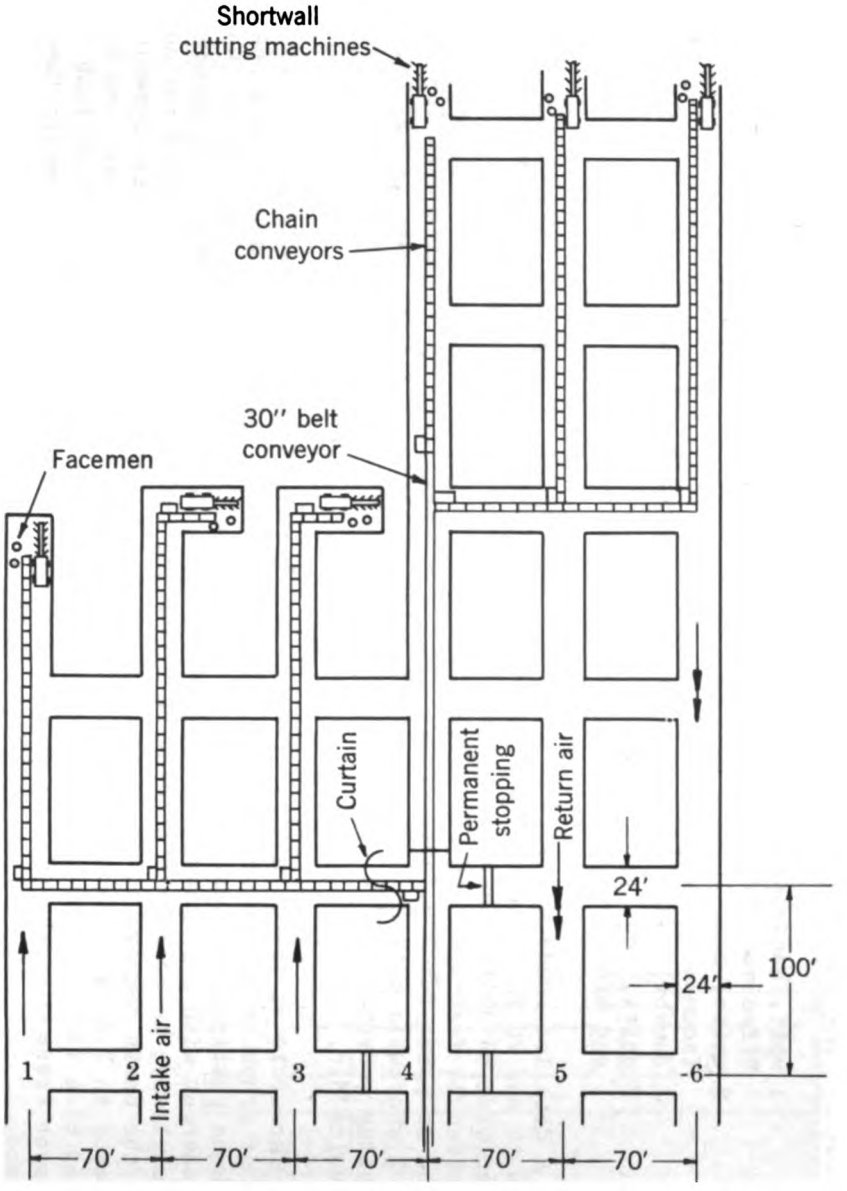

Figure 9. - Method of development at mine 3.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

1 unit, hand-loading onto chain conveyors, developing entries; 12-1/2 facemen each shift.
1 unit, hand-loading onto chain conveyors, mining rooms; 6-1/2 facemen, first shift; 4-1/2 facemen, second shift.
2 units, loading into mine cars; 35 facemen on first shift; 12 facemen on second shift developing entries and mining rooms.

A detailed study was made of the 12-1/2-man entry-development unit. Main entries 24 feet wide are driven in sets of 6 on 70-foot centers, with crosscuts 24 feet wide on 100-foot centers. (See fig. 9.) These entries are developed by a unit of 12-1/2 men, 6 shortwall cutting machines, 6 handheld electric drills, 6 entry chain conveyors, 2 mother chain conveyors, 6 face chain conveyors, and a 30-inch belt. Power to operate the mining equipment is furnished at 250 volts d.c. Each entry is advanced by a crew of two facemen.

The cycle of operation is: Cut, drill, blast, load coal, extend chain conveyor, and timber; some of these operations are done simultaneously. Wood posts spaced on 5-foot centers and, where required, 4- by 8-inch by 12-foot wood crossbars set on wood posts, support the roof. Entries are bottom-cut; and 4 holes, each 7 feet long, are drilled 4 inches below the roof and spaced on 5-foot centers. Each hole is charged with 3 or 4 sticks of permissible explosive and detonated 1 hole at a time. Rock dusting is done on shift by hand casting.

The coal is hand-loaded onto chain conveyors, transported, and discharged onto a 30-inch belt in entry 4. The coal is conveyed to the surface and discharged to a bin, then loaded to 2-1/2-ton steel mine cars, which are transported to the preparation plant by a 15-ton locomotive in 30-car trips. The haulage track is 60-pound rail laid on 42-inch gage.

A unit crew consists of the following men:

Section foreman	1/2
Facemen (6 entries, 2 men each)	12
Total	12-1/2

A unit crew produces an average of 156 tons of raw coal per shift, or 12.5 tons per man-shift. The average advance in each entry in a development group is 5.5 feet per shift, a total of 33 feet for the group.

Mine 4

This mine is operated in the Lower Kittanning or B coal bed, which averages 42 inches thick in this area. (See fig. 10.) Only 38 inches of the bed is mined. The top 4 inches is bone coal and usually is left unmined. Over the bone coal is 3 to 4 feet of gray shale, above which is a stratum of sandy shale 60 feet or more thick. The overburden consists mainly of sandstones and shales and averages 280 feet in thickness.

The mine is operated 2 shifts per day and produces an average of 627 tons of raw coal (552 tons of clean coal), using the following units:

1 conveyor-mobile-loading unit developing panel entries; 9 facemen.
1 conveyor-mobile-loading unit mining rooms and pillars; 3 facemen.
1 conveyor-mobile-loading unit developing other entries; 6 facemen.
2 hand-loading units mining rooms and pillars; 8 men.

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:53 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

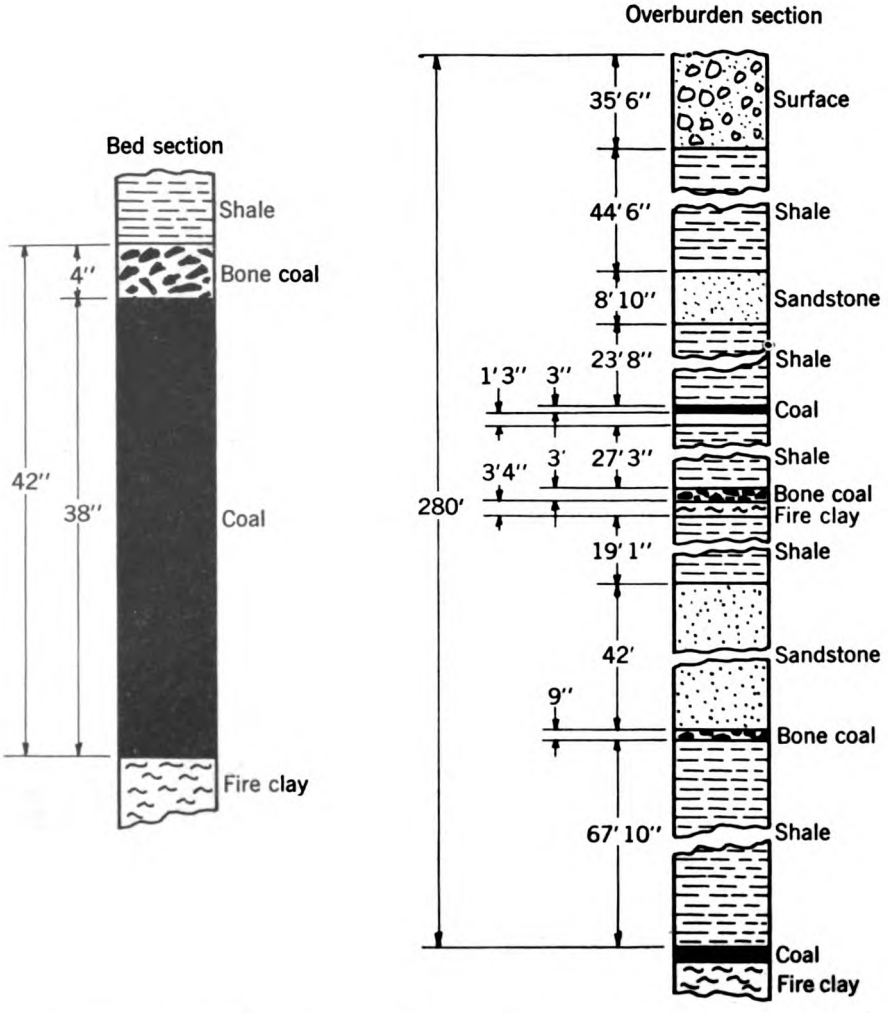

Figure 10. - Section of coal bed and overburden at mine 4.

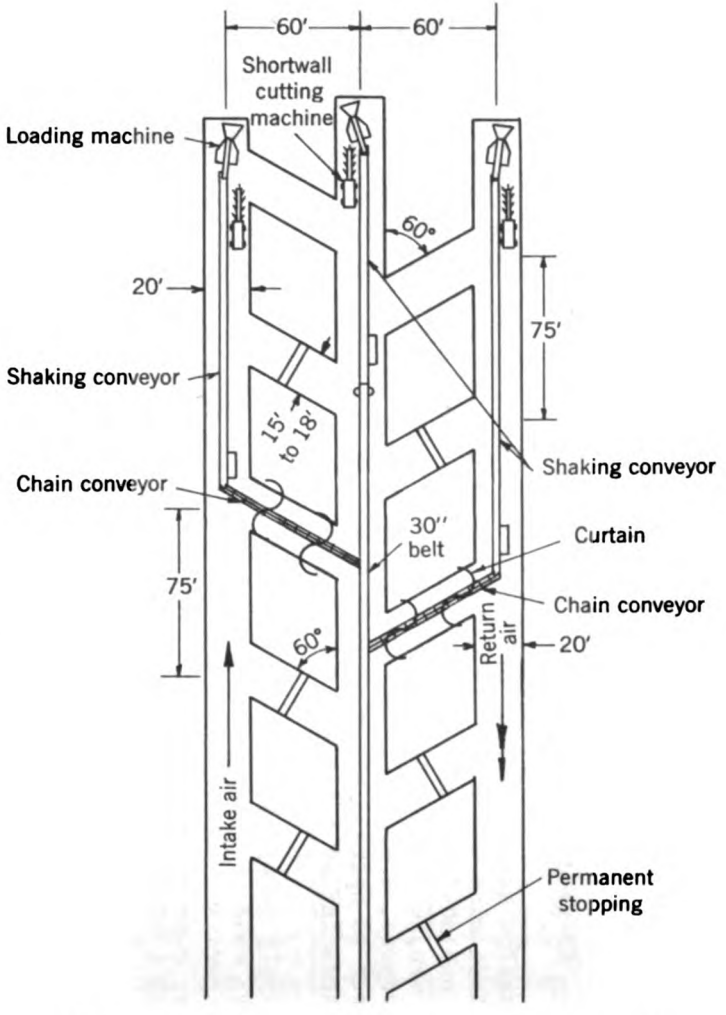

Figure 11. - Method of development at mine 4.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

A detailed study was made of the 9-man entry-development unit only. Panel entries 20 feet wide are driven in sets of 3 on 60-foot centers, with crosscuts 15 to 18 feet wide on 75-foot centers. (See fig. 11.) These entries are developed by a unit consisting of 9 men, 3 mobile-loading machines, 3 shortwall cutting machines, 3 handheld electric drills, 3 shaker conveyors, 2 chain conveyors, and 1 belt conveyor.

The cycle of operation is: Timber, cut and drill, blast, and load coal. Power to operate all equipment is furnished at 550 volts d.c. Four-inch aluminum alloy I-beams, 16 and 24 feet long and set on wood posts on 6-foot centers, support the roof when required. These beams are recovered on retreat from the working places.

The center entry is top-cut, and the outside entries are bottom-cut to a depth of 8 feet. The center entry is top-cut to provide a better roof in the belt entry. Four equally spaced holes, drilled 1 foot below the roof and each charged with 3 to 4 sticks of explosive, are used to break the coal in the entries that are bottom-cut. Holes in the belt entry are drilled 1 foot above the bottom.

The coal is loaded onto shaker conveyors. In the middle entry the shaker conveyor end-loads onto the 30-inch belt, but in the two outside entries the coal from the shaker conveyors is transferred to chain conveyors through crosscuts to the 30-inch belt. Coal is loaded from the 30-inch belt conveyor into 3-ton mine cars for transportation to the mine tipple. The 30-inch belt is extended every 150 feet of advance of the belt entry. Chain conveyors in the crosscuts are moved every 300 feet of advance.

Rock dusting is done by hand on shift and on weekends by machine in the entries.

A unit crew consists of the following men:

Section foreman	3/4
Loading-machine operators	3
Cutting-machine operators	3
Scrapers	3
Oiler	3/4
Boom man	3/4
Total	11-1/4

A unit crew produces an average of 114 tons of raw coal per shift, or 10.4 tons per man-shift. The average advance in each entry in a development group is 10.2 feet per shift, a total of 32.3 feet for the group.

Mine 5

This mine is operated in the Lower Kittanning or B coal bed, which averages 75 inches in thickness in this area. (See fig. 12.) The top 6 inches is bony coal and usually is left unmined. Two shale partings, each 4 inches thick, occur 6 and 22 inches above the bottom of the bed. Only the 43-inch portion of the bed between the bony coal and upper parting is mined. The coal bed usually is overlain with shale. At times the shale is replaced with an unconsolidated sandstone, which provides a poor roof. The overburden consists mainly of shales and sandstones and averages 444 feet in thickness.

The mine is operated 3 shifts per day and produces an average of 2,107 tons of raw coal per day (which requires no cleaning), with the following units:

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

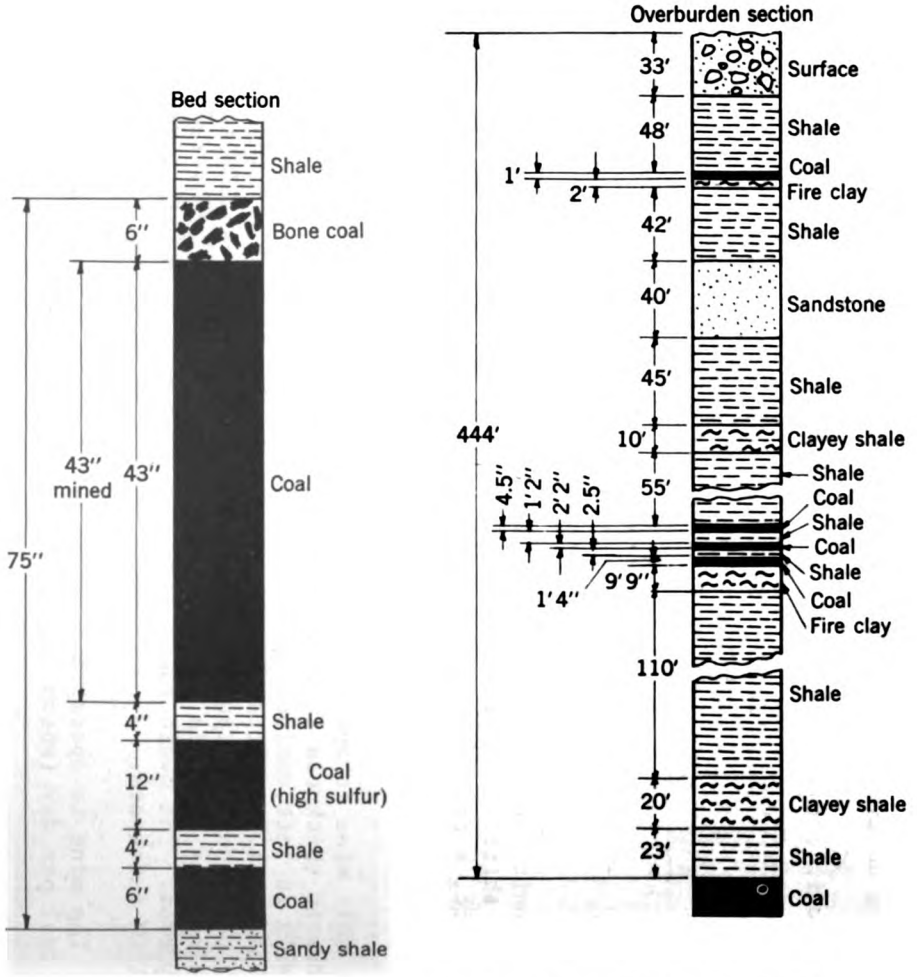

Figure 12. - Section of coal bed and overburden at mine 5.

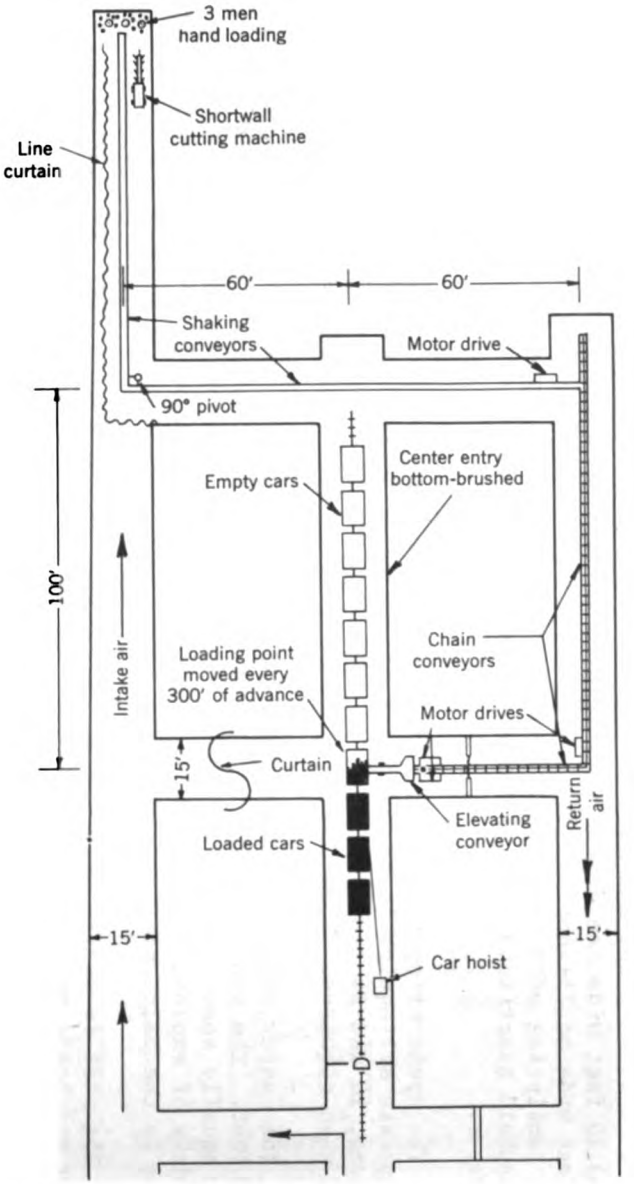

Figure 13. - Method of development at mine 5.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

1 mobile-loading unit developing entries, working 2 shifts per day.
3 mobile-loading units mining rooms and pillars, working 8 unit shifts per day.
2 units, hand-loading onto shaker conveyors, developing entries, working 2 shifts per day.
1 group, 67 men hand-loading into mine cars, working partly on first and second shifts.

A unit developing a set of panel entries by hand loading onto conveyor methods was studied in detail. Panel entries 15 feet wide are driven in sets of 3 on 60-foot centers, with crosscuts 15 feet wide on 100-foot centers. (See fig. 13.) Entries are advanced 1 at a time in segments of 100 feet. These entries are developed by a unit of 4 men, 1 shortwall cutting machine, 1 handheld electric drill, 1 shaker conveyor with 300 feet of pans, 2 chain conveyors, 1 elevating conveyor, and 1 car-spotter hoist. Power to operate equipment is furnished at 250 volts d.c.

The cycle of operation is: Timber, drill, cut, extend conveyor, blast, and load coal. Wood posts set 4 feet from the left rib on 4-foot centers support the roof. Four holes 8 feet long, spaced 4 feet apart and 1-1/2 feet from the ribs, are drilled 1 foot above the bottom. The coal faces are cut immediately below the bone-coal roof. Drill holes are charged with five sticks of permissible explosive and blasted one hole at a time.

Rock dusting is done on shift by hand and on weekends by machine in the entries.

The coal is hand-loaded onto a shaker conveyor, from which it is transported by two chain conveyors and an elevating conveyor to mine cars in the middle entry in the sequence shown in figure 13. The mine cars are used for transporting the coal to the surface. The middle entry is bottom-brushed. A mine-car loading point is established every 300 feet of advance. The crew of four men works together and interchanges the various duties in the mining cycle, including operation of the conveyors and car-spotter hoist. One-fourth of the time of a section foreman is assigned to the unit.

A unit crew produces an average of 57.5 tons of raw coal per shift, or 13.5 tons per man-shift. The average advance in each entry in a development group is 5 feet per shift, a total of 15 feet for the group.

Mine 6

This mine is operated in the Ohio No. 6 (Middle Kittanning) coal bed, which averages 46 inches in thickness in this area. (See fig. 14.) The bed has a slight regional dip to the southeast, with local dips and rolls in the bottom. A shale parting 1 inch thick occurs 24 inches above the bottom. The coal is underlain by a firm fire clay and overlain by about 25 feet of shale that usually provides good roof conditions. The overburden averages 295 feet in thickness and consists principally of shales and sandstones.

The mine is operated 2 shifts daily and produces an average of 2,832 tons of raw coal (2,549 tons of clean coal). The total mine production comes from entry development and room mining by the following unit crews, using mobile-loading equipment and shuttle cars:

1 unit crew of 12 men developing panel entries.
3 unit crews of 12 men each in room mining.

Generated on 2024-09-21 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:58 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

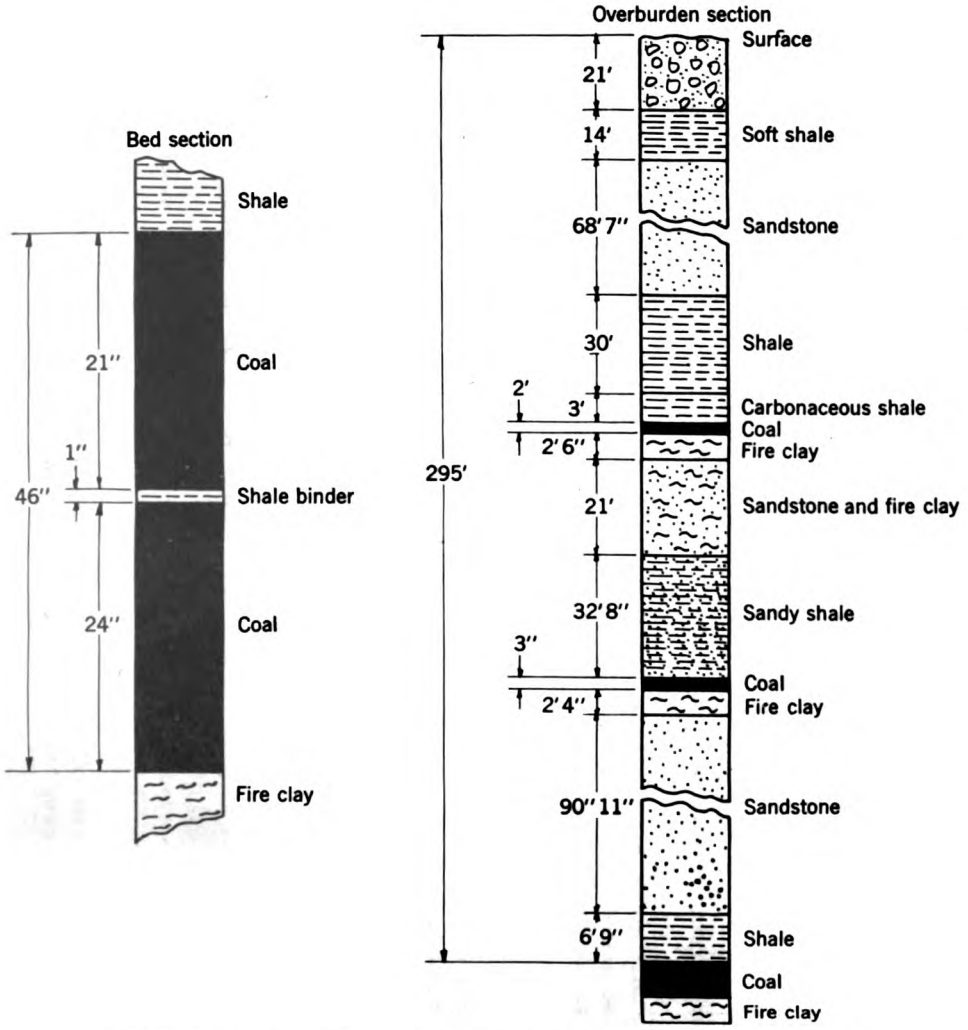

Figure 14. - Section of coal bed and overburden at mine 6.

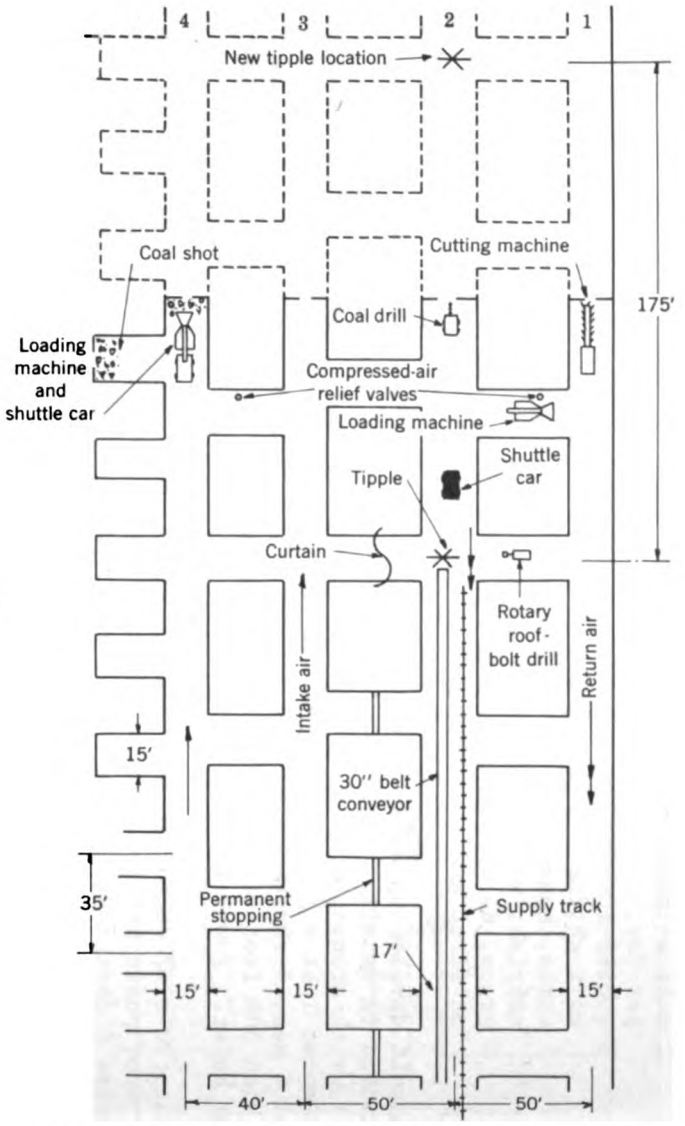

Figure 15. - Method of development at mine 6.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The 12-man entry-development unit was studied in detail. Panel entries 15 and 17 feet wide are driven in sets of 4. Entries 1, 2, and 3 are on 50-foot centers, and entry 4 is on 40-foot centers. (See fig. 15.) The haulage entry (No. 2) is driven 17 feet wide, and the other 3 entries are 15 feet wide. Crosscuts are driven 15 feet wide on varying centers as projected on the mining plan. Rooms are necked 15 feet wide on 35-foot centers as entry 4 advances. In addition to the 12-man crew, the unit is comprised of: 2 mobile-loading machines, 2 shuttle cars, 1 universal cutting machine, 1 rotary drill on a tractor-mounted buggy, 4 compressed-air tubes and 2 relief or blowdown valves for blasting, 1 roof-bolting machine, a 30-inch belt conveyor, and a supply track of 30-pound rail on 42-inch gage. Power to operate the equipment is furnished at 250 volts d.c.

The cycle of operation is: Roof-bolt (when required), drill, cut, blast, and load coal.

Entries are roof-bolted with 5/8-inch diameter by 36-inch expansion shell type bolts set against 6- by 6- by 1/4-inch steel bearing plates. The bolts are set on about 4-foot centers.

Six holes are drilled 8 feet in depth in the coal at the face. One hole is drilled just below the parting and in the center of the entry. Two others are drilled just above the parting and one on each rib. The other 3 holes are drilled about 8 inches below the roof, 1 on each rib and 1 in the center. The coal is undercut and blasted, 1 hole at a time, with a compressed-air shell.

Rock dusting is done by hand on shift and between shifts, when required.

The coal is loaded into 2-1/2-ton shuttle cars, transported, and dumped onto a 30-inch belt conveyor. This conveyor feeds onto a 30-inch mother belt conveyor in the main entry.

The panel belt and the supply track are advanced, and a new loading station is established every 175 feet of haulage-entry advance.

A unit crew consists of the following men:

Section foreman	1
Loading-machine operator	1
Loading-machine operator's helper	1
Cutting-machine operator	1
Cutting-machine operator's helper	1
Drillers	2
Shot firer	1
Shuttle-car operators	2
Mechanic	1
Cleanup man	1
Total	12

When roof bolting is necessary, one additional man is used in the crew.

A unit crew produces an average of 303 tons of raw coal per shift, or 25.3 tons per man-shift. The average advance in each entry in a development group is 22 feet per shift, a total of 88 feet for the group.

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Mine 7

This mine is operated in the Sewell coal bed, which averages 44 inches thick in this area. (See fig. 16.) The bed is flat lying, but some rolls and faults are encountered in mining. A shale parting 1 inch thick occurs 21 inches above the bottom of the bed. The coal is underlain by a hard, clayey shale that provides good roadways for the trackless mobile equipment. The bed is overlain with 2 inches of draw slate that is removed in mining. The overburden averages 436 feet in thickness and consists mainly of shales and sandstones.

The mine is operated 3 shifts daily and produces an average of 3,638 tons of raw coal (3,456 tons of clean coal) using the following units:

2 continuous-mining, piggyback chain-conveyor units of 7 men each, developing entries and mining rooms, 2 shifts per day.
2 mobile-loading, piggyback chain-conveyor units working as a single unit, 13 men, developing entries, 3 shifts per day.
4 mobile-loading, piggyback chain-conveyor units of 7 men each, developing entries and mining rooms, 2 shifts per day.
2 mobile-loading, shuttle-car units of 10 men each, developing entries, 2 shifts per day.
1 mobile-loading, shuttle-car unit of 7 men developing entries and mining rooms, 2 shifts per day.

One of the continuous-mining units on entry development was studied in detail. Main entries 27 feet wide are driven in sets of 9 on 60-foot centers, with crosscuts 18 feet wide on 75-foot centers. (See figs. 17 and 18.) These entries are developed by a unit consisting of 9 men, 1 boring-type continuous-mining machine, 1 mobile-loading machine, 1 piggyback conveyor, 2 chain conveyors, and a 30-inch belt conveyor. Power to operate the equipment is furnished at 440 volts a.c.

Entries are advanced with a continuous-mining machine by making 3 successive cuts, each 9 feet wide and 42 feet long. (See fig. 18.) Crosscuts are advanced in a similar manner with two 9-foot cuts.

Entries 1 and 2, or 8 and 9, are advanced in alternate steps of 75 or 150 feet for 300 feet, and crosscuts are turned from either entry. Blind crosscuts are turned from either entry. Blind crosscuts are turned to the unmined side on the advance. The adjoining entry then is advanced 300 feet, breaking into the previously mined crosscuts, and blind crosscuts also are turned to the unmined side. This sequence of operation is followed in the remaining entries to complete the 300 feet of advance.

Coal mined by the continuous-mining machine is deposited on the floor. The coal is reloaded by the mobile-loading machine and is transported by the piggyback conveyor, 2 chain conveyors, the 30-inch belt conveyor in entry 5, and the 36-inch, main-haulage belt conveyor to the preparation plant on the surface.

Wood posts, set on 5-foot centers, support the roof. Rock dusting is done by hand-casting on shift and with a machine on weekends.

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 15:00 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

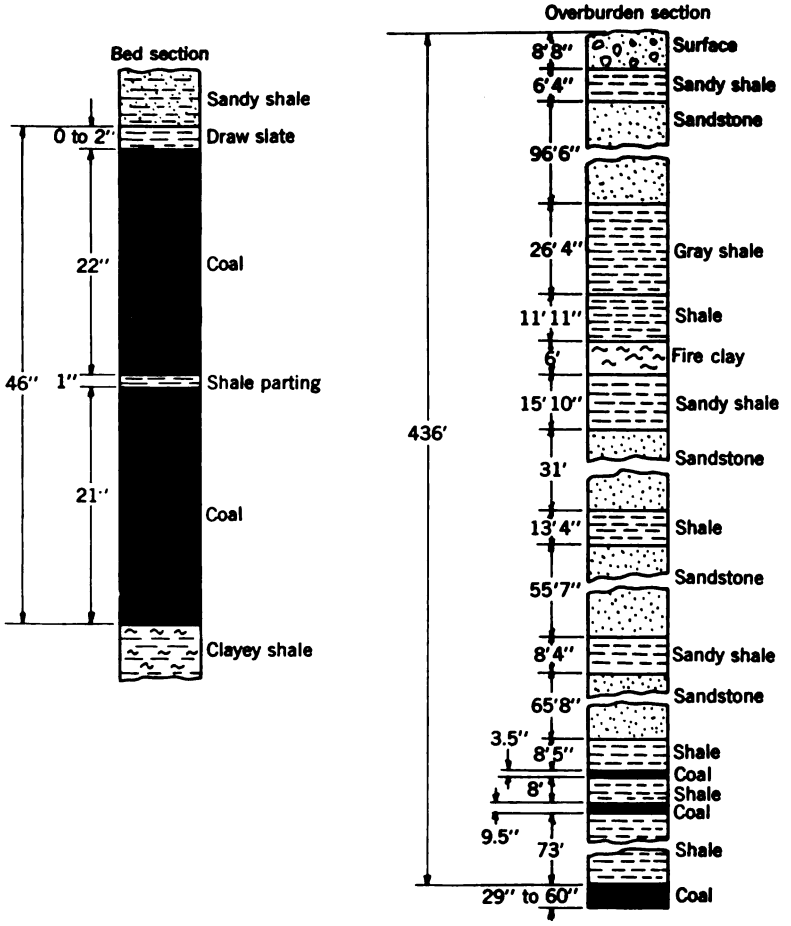

Figure 16. - Section of coal bed and overburden at mine 7.

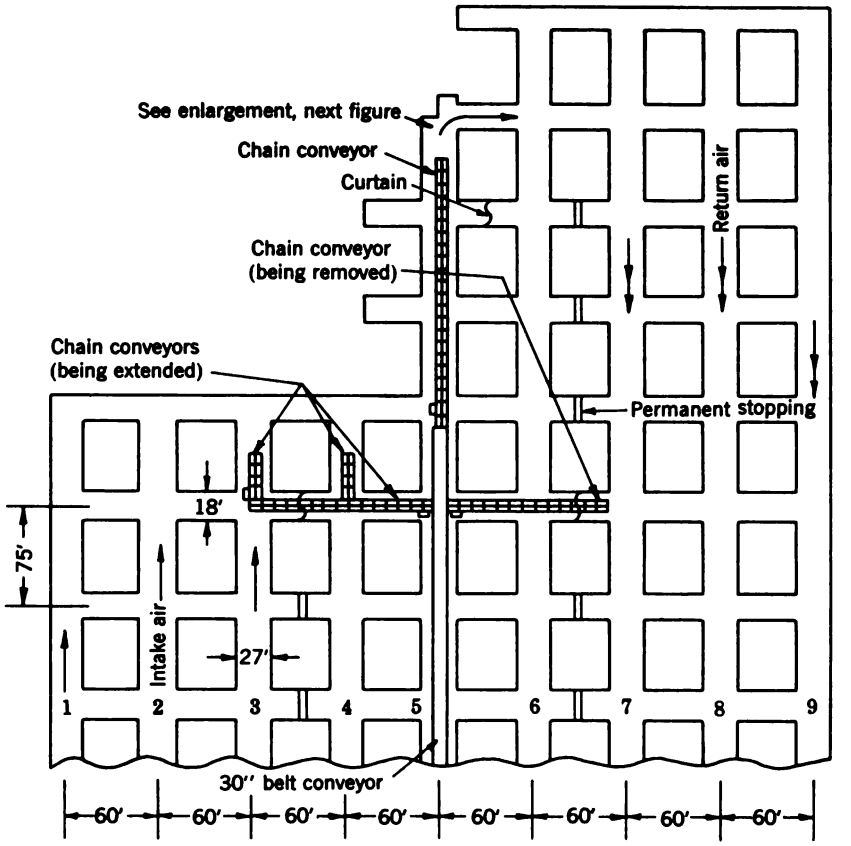

Figure 17. - Method of development at mine 7.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

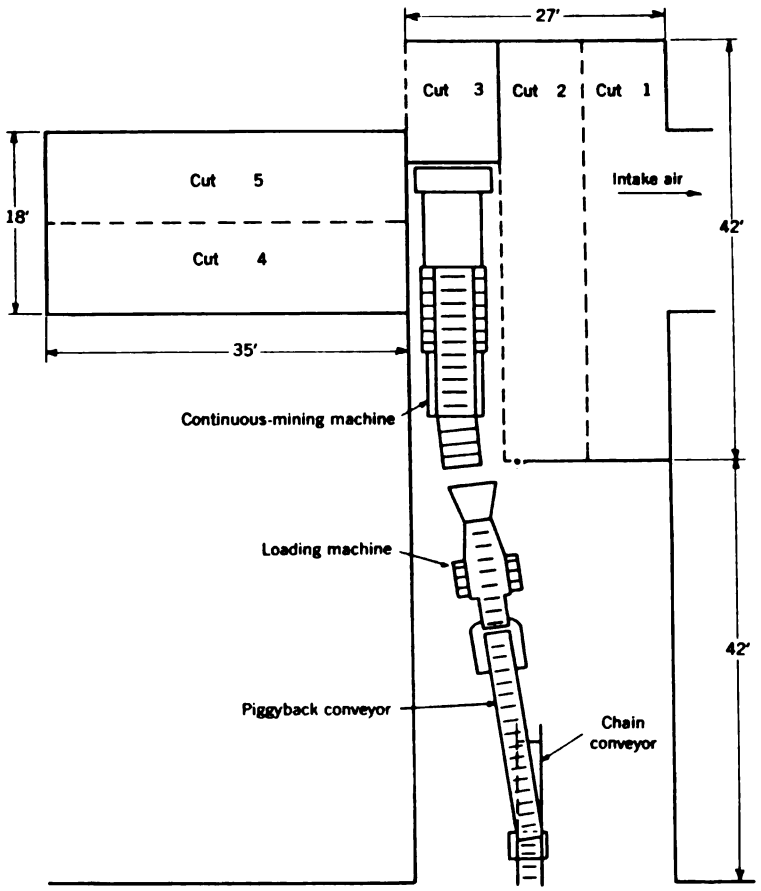

Figure 18. - Sequence of cuts by continuous-mining machine at mine 7.

A unit crew consists of the following men:

Section foreman	1
Continuous-mining-machine operator	1
Continuous-mining-machine operator's helper	1
Loading-machine operator	1
Loading-machine operator's helper	1
Supply man	1
Mechanic	1
Total	7

A unit crew produces an average of 299 tons of raw coal per shift, or 42.8 tons per man-shift. The average advance in each entry in a development group is 6.1 feet per shift, a total of 54.5 feet for the group.

Mine 8

This mine is operated in the Coalburg bed, which is 73 inches thick in the area. A shale parting 6 inches thick occurs 12 to 18 inches above the bottom of the coal bed. Only the coal above this parting (about 55 inches) is mined. (See fig. 19.) The roof generally is firm sandstone, but in parts of the mine the immediate roof is shale. The overburden consists of shales and sandstones and averages 200 feet in thickness.

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

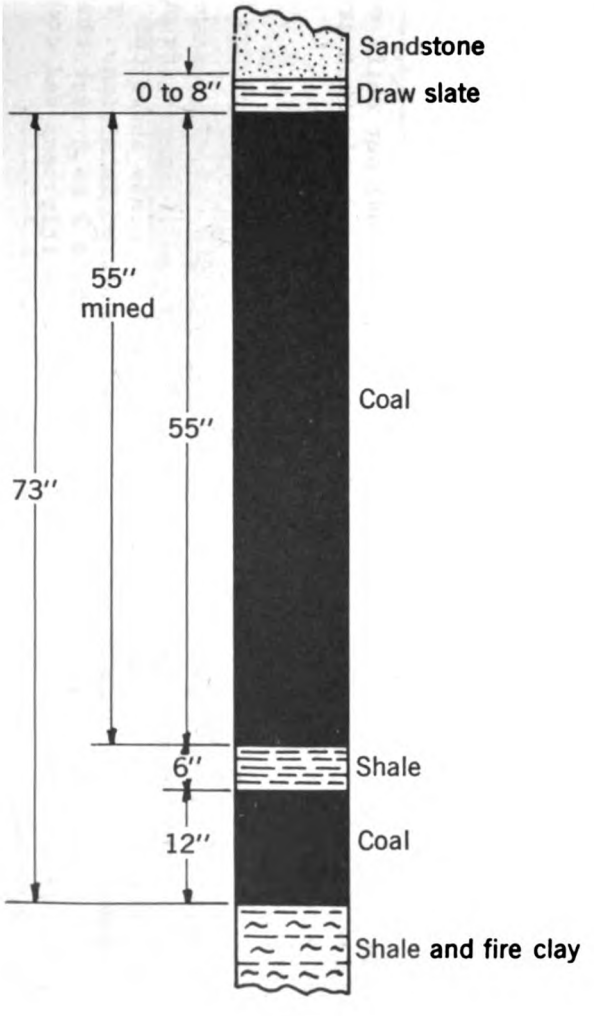

Figure 19. - Section of coal bed at mine 8.

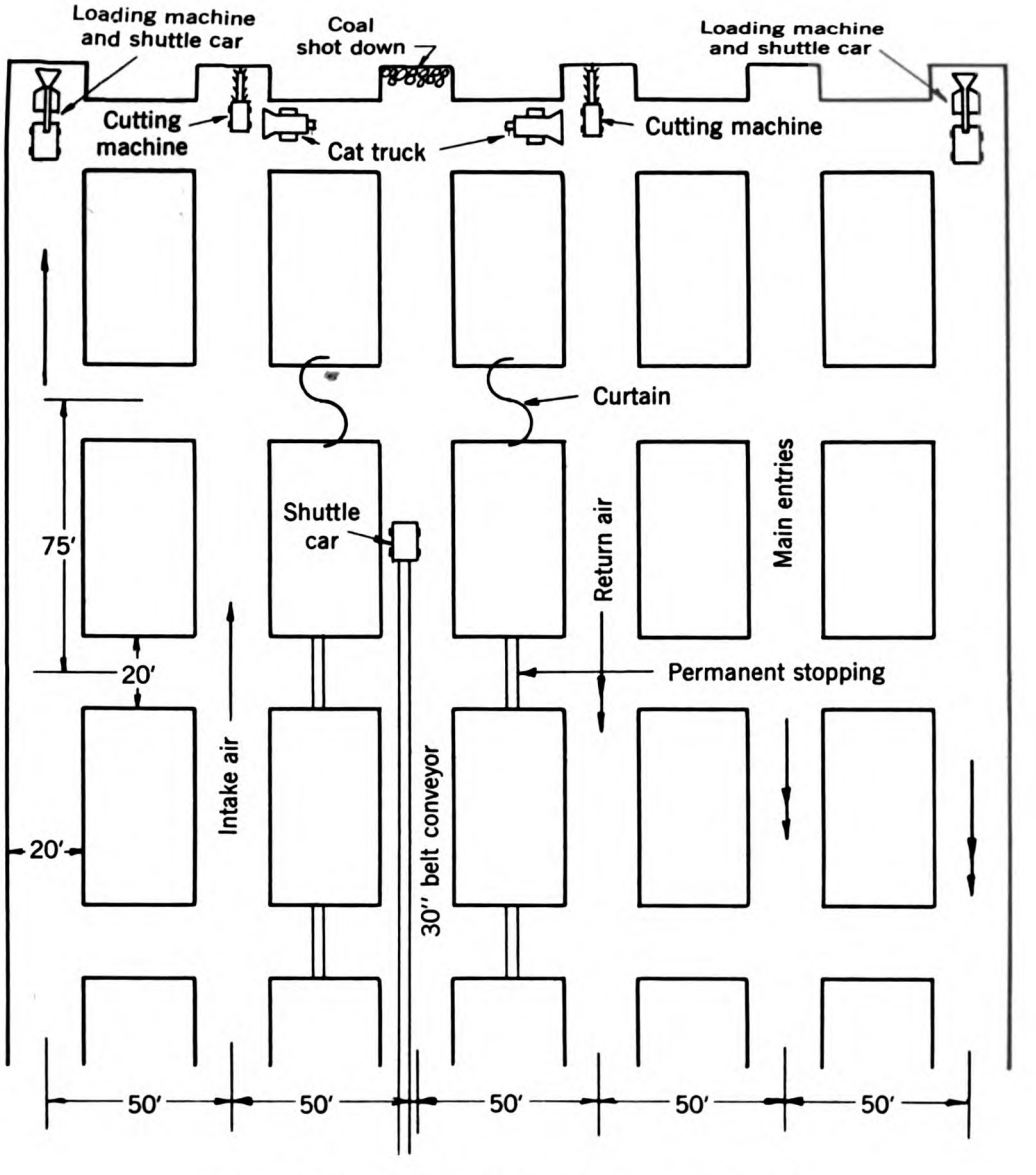

Figure 20. - Method of development at mine 8.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The mine is operated 2 shifts per day and produces an average of 1,541 tons of raw coal (1,376 tons of clean coal), using the following units:

1 mobile-loading unit with shuttle cars, developing main entries; 12 facemen.
1 conveyor mobile-loading unit with piggyback, developing panel entries and mining rooms; 6 facemen.

The 12-man entry-development unit was studied in detail. Main entries 20 feet wide are driven in sets of 6 on 50-foot centers, with crosscuts 20 feet wide on 75-foot centers. (See fig. 20.) These entries are developed by a unit consisting of 12 men, 2 mobile-loading machines, 2 shortwall cutting machines with caterpillar trucks, 3 shuttle cars, 2 handheld coal drills, and a 30-inch belt conveyor. Power to operate equipment is furnished at 250 volts d.c.

The cycle of operation is: Timber, drill, cut, blast, and load coal. Props are used to support the roof where the roof is sandstone. However, when it is shale, the roof requires more timbering; then 3- by 8-inch by 16-foot wood crossbars set on wood posts are used.

After timbering, the working place is drilled for blasting. Usually 6 holes, each 7 feet long, are drilled in the coal. Three holes are drilled 1 foot below the roof, and 3 others are drilled 2 feet below the roof. The holes in the lower group are staggered between those in the upper group.

The entries are bottom-cut after drilling then the coal is blasted, using 4 sticks of permissible explosives per hole and blasting 1 hole at a time.

The coal is loaded by loading machines into shuttle cars and transported to the 30-inch belt conveyor in the No. 3 entry for transportation to the surface.

Rock dusting is done onshift by hand casting and offshift by machine.

A unit crew consists of the following men:

Section foreman	1
Loading-machine operators	2
Loading-machine operators' helpers	2
Cutting-machine operators	2
Cutting-machine operators' helpers	2
Shuttle-car operators	3
Total	12

A unit crew produces an average of 509.5 tons of raw coal per shift or 42.5 tons per man-shift. The average advance in each entry in a development group is 18.2 feet per shift, a total of 108.6 feet for the group.

Mine 9

This mine is operated in the Upper Kittanning (C') bed, which averages 59 inches in thickness in this area. (See fig. 21.) The bed has a dip ranging from 1° to 3°. Two shale partings, each 2 inches thick, occur 19 and 36 inches above the bottom of the bed. Numerous clay veins and horsebacks are encountered in mining. The coal is underlain by a soft fire clay and overlain by a weak shale 2 to 3 feet thick, above which is sandstone. The overburden averages 284 feet in thickness and consists mainly of sandstones and shales.

Generated on 2024-09-21 14:53 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

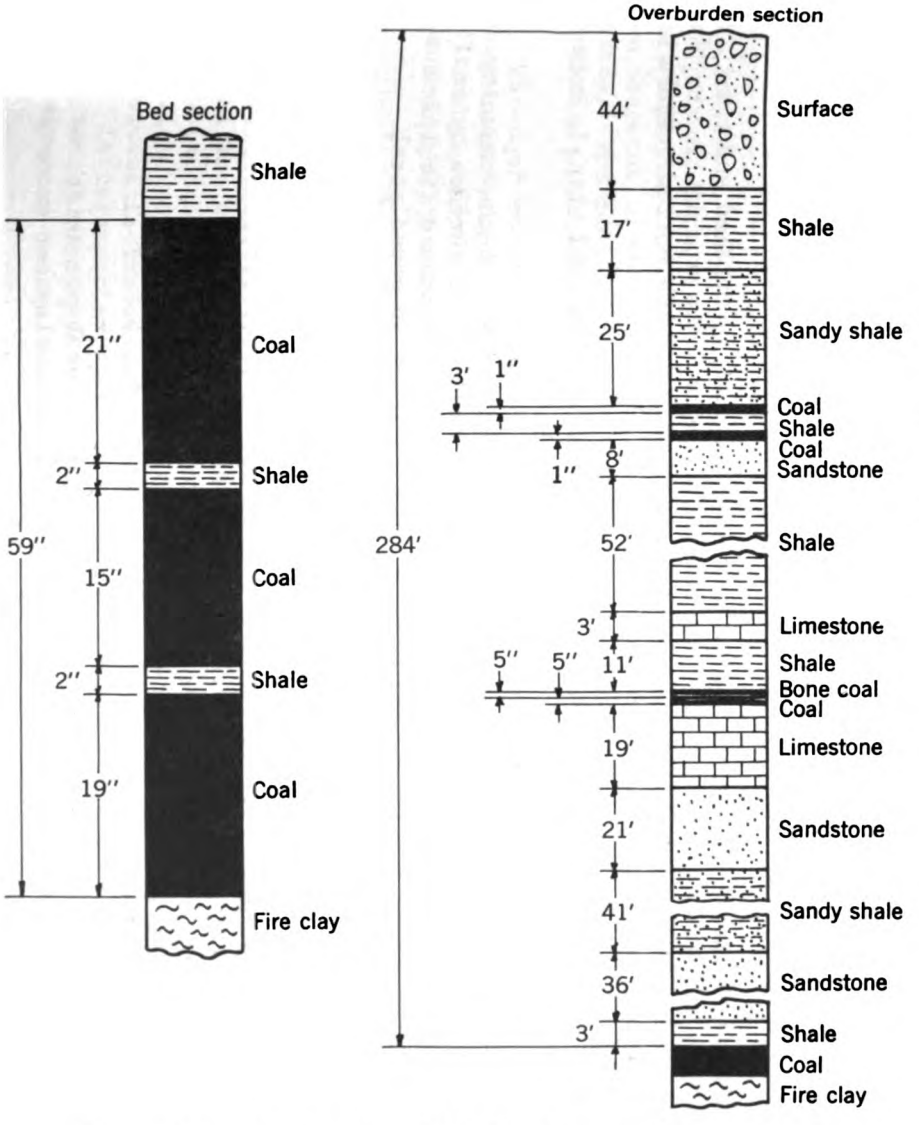

Figure 21. - Section of coal bed and overburden at mine 9.

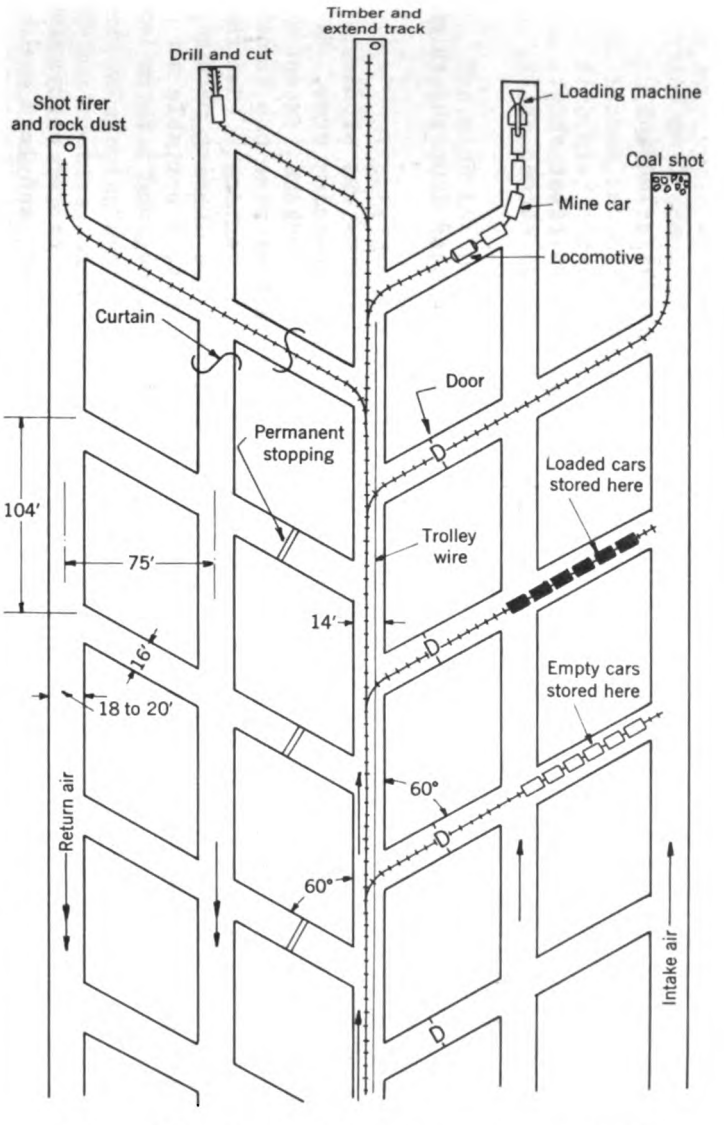

Figure 22. - Method of development at mine 9.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The mine is operated 3 shifts daily and produces an average of 1,900 tons of raw coal (1,520 tons of clean coal). The total mine production comes from entry development by the following unit crews, using track-mounted mobile-loading equipment:

6 unit crews of 9 men each and 2 crews of 5 men each on first shift.
6 unit crews of 9 men each and 2 crews of 5 men each on second shift.
2 unit crews of 9 men each on third shift.

There are 2 mechanics on the first shift, 2 on the second, and 1 on the third shift to keep the machines in repair.

One of the 9-man units operated on the first and second shifts was studied; this unit had a roof-bolt man on each shift, in addition to the regular crew. Entries 18 to 20 feet wide are driven in sets of 5 and on 75-foot centers, except the center or haulage entry, which is 14 feet wide. Crosscuts 16 feet wide are turned 60° to the left and right from the center entry and on 104-foot centers. (See fig. 22.) In addition to the 10-man crew the unit is comprised of: 1 loading machine, 1 universal cutting machine, 1 handheld electric drill, 1 stoper, 1 portable air compressor, 1 compressed-air tube, 6 blowdown valves for blasting, and 1 8-ton locomotive.

The cycle of operation is: Brush roof, and bolt and timber center entry, timber other four entries, extend track, drill and cut, blast, rock-dust, and load coal. Power to operate equipment is furnished at 250 volts d.c.

The center entry is top-brushed and roof-bolted with 3/4-inch wedge-type bolts 4 feet long, set against 3/8- by 6- by 6-inch steel bearing plates. The bolts are spaced on 4-foot centers. All entries are timbered with 6- by 6-inch by 14-foot wood crossbars set on wood posts.

Track is extended in the entry, after which the coal is drilled and cut. Cutting is done between the two partings in the bed. Three holes are drilled by the cutting-machine crew near the top of the bed and three near the bottom. These holes are drilled 9 feet long and blasted 1 at a time.

The shot firer rock dusts by hand on shift and a two-man crew using a rock-dusting machine rock dusts off shift in the haulage entry.

The coal is loaded by a track-mounted loading machine into 6-ton-capacity steel mine cars with bottom dump. Loaded cars are transported to the surface by trolley locomotive. The haulage track is of 60-pound rail laid on standard (56-1/2-inch) gage. The face haulage track in the other 4 entries is of 30-pound steel.

A unit crew consists of the following men:

Section foreman	1	Roof bolter	1
Loading-machine operator	1	Timberman	1
Loading-machine operator's helper	1	Mechanic	1/4
Cutting-machine operator	1	Motorman	1
Cutting-machine operator's helper	1	Brakeman	1
Shot firer	1	Total	10-1/4

A unit crew produces an average of 134 tons of raw coal per shift, or 9.7 tons per man-shift. The average advance in each entry in a development group is 6.1 feet per shift, a total of 30.4 feet for the group.

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Mine 10

This mine is operated in the flat-lying Leatherwood bed, which ranges from 41 to 65 inches in thickness in this area. (See fig. 23.) The bed is underlain by a soft fire clay and overlain by shale (draw rock), which averages 20 inches in thickness. The overburden averages 228 feet in thickness and consists mainly of shales and sandstones.

The mine is operated 2 shifts daily and produces an average of 4,710 tons of raw coal (4,098 tons of clean coal), with the following units:

1 mobile-loading, piggyback chain-conveyor unit developing entries; 12 facemen.
2 mobile-loading, shuttle-car units developing entries; 12 facemen each.
2 mobile-loading, shuttle-car units in room mining; 12 facemen each.
1 mobile-loading shuttle-car unit extracting pillars; 14 men; 1 shift per day.

A detailed study was made of the 12-man mobile-loading, piggyback chain-conveyor unit developing entries. Main entries 25 to 27 feet wide are driven in sets of 6 on 60-foot centers, with crosscuts 25 feet wide on 90-foot centers. (See fig. 24.) These entries are developed by a unit consisting of 12 men, 1 loading machine, 1 universal cutting machine, 1 handheld hydraulic drill, 2 piggyback conveyors, 1 stoper with dust collector, 1 portable air compressor, 2 entry conveyors, 1 mother conveyor, 1 elevating conveyor, 1 car-spotter hoist, and 1 supply truck. Power to operate the mining equipment is furnished at 275 volts d.c.

The cycle of operation is: Bolt roof, cut, drill, rock-dust, blast, extend chain conveyor, and load coal.

Entries 1 and 2 are advanced 300 feet, and the equipment then is moved to the next pair of entries (3 and 4), which are advanced the same distance. Entries 5 and 6 are advanced in a like manner, and the equipment then is moved through the last open crosscut to entries 1 and 2 and the same procedure followed to advance the six entries. The chain conveyor is advanced alternately 6 and 12 feet on each cut and maintained within 30 feet of the face.

The roof is bolted with 3/4-inch, expansion, shell-type bolts 3 and 4 feet long set against 4- by 4- by 3/8-inch steel bearing plates with wood headers 3 feet long by 8 inches wide by 2 inches thick between the plate and roof. Bolts are set 7-1/2 feet from the ribs in rows on 5-foot centers. Bolts in each row are 4 feet apart.

Entries are bottom-cut and sheared 5 feet from the right rib to a depth of 9 feet. Three holes 9 feet long are drilled near the roof, 1 in the center and 1 near each rib. Each hole is charged with four sticks of permissible explosive and blasted.

Rock dusting is done by hand on the operating shifts and by machine on the third shift.

The coal is loaded by the loading machine onto the piggyback conveyor, from which it is transported by 2 chain conveyors and an elevating conveyor to 5-ton-capacity steel mine cars in entry 3 in the sequence shown in figure 24. Loaded cars are transported to the surface in 22 car trips by 15-ton locomotives. The haulage

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 15:00 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

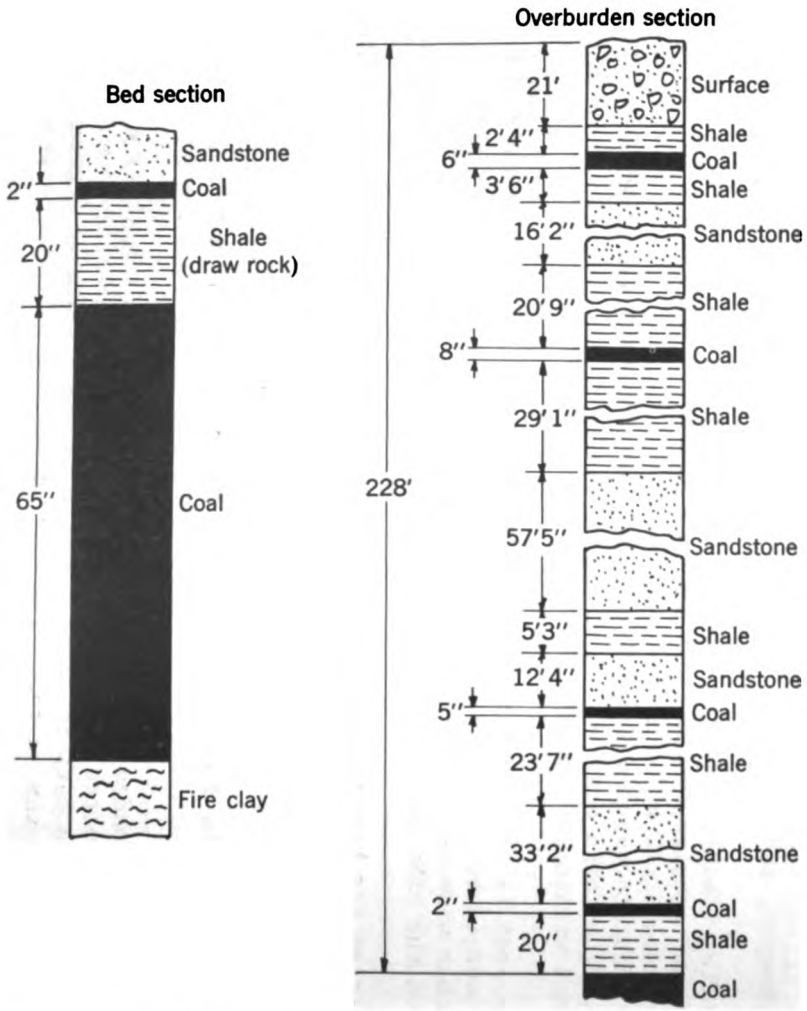

Figure 23. - Section of coal bed and overburden at mine 10.

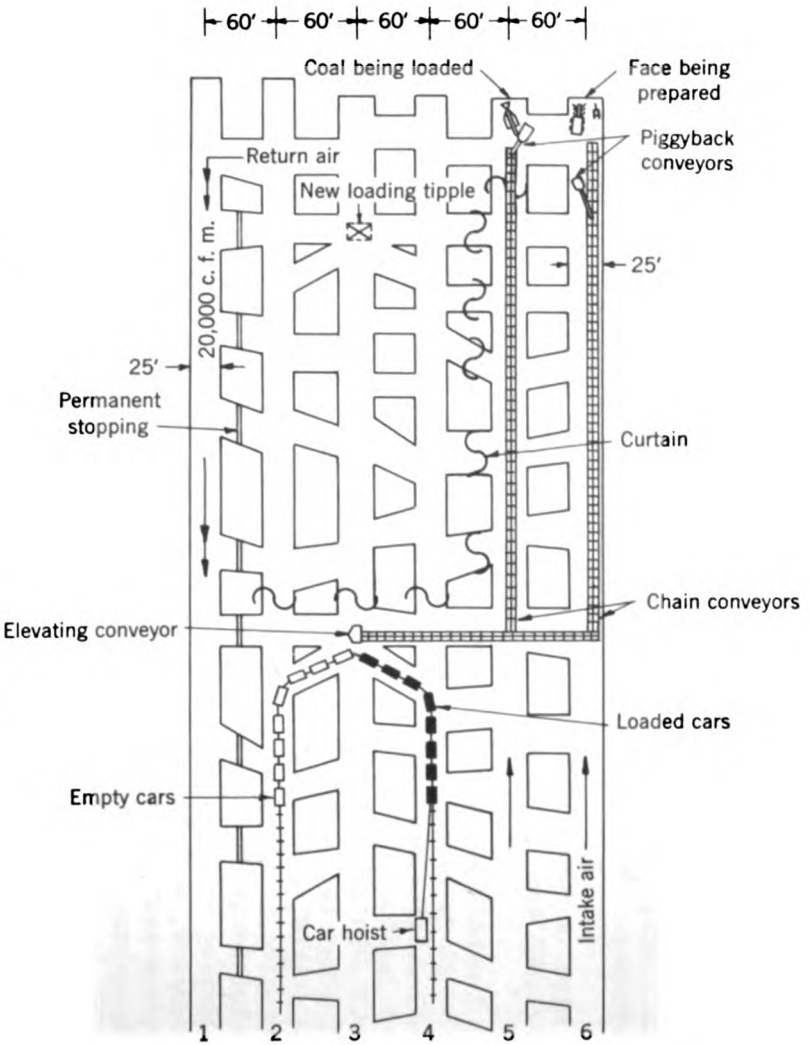

Figure 24. - Method of development at mine 10.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

track is 80-pound rail (44-inch gage) in the mains and 50-pound in the panel entries. The loading station is reestablished after each 300-foot advance of the group of development entries.

A piggyback unit crew consists of the following men:[1/]

Section foreman	1
Loading-machine operator	1
Loading-machine operator's helper	1
Cutting-machine operator	1
Cutting-machine operator's helper	1
Shot firer	1
Roof bolters	2
Timberman	1
Pan movers (chain conveyors)	2
Boom man	1
Total	12

1/ Mechanic not shown; all maintenance work done on third shift.

The unit studied produced an average of 468 tons of raw coal per shift, or 39 tons of coal per man-shift. The average advance in each entry in a development group is 8.9 feet, a total of 53.3 feet for the group.

Mine 11

This mine is operated in the flat-lying Pittsburgh bed, which averages 85 inches in thickness in this area. (See fig. 25.) A shale parting 1 inch in thickness occurs at the middle of the coal bed, and 2 others at 6- and 4-inch intervals above this parting. The coal is overlain by 5 inches of draw slate, above which is 7 inches of rider coal. Above the rider coal is a stratum of weak shale averaging 6 to 15 feet in thickness. The coal is underlain by hard fire clay. The overburden averages 530 feet in thickness and consists mainly of shales and sandstones.

The mine is operated 3 shifts daily and produces an average of 4,783 tons of raw coal (4,400 tons of clean coal), with the following units:

4 mobile-loading units of 13 men each, developing entries, 2 shifts per day.
1 mobile-loading unit of 13 men, developing entries, 3 shifts per day.
2 continuous-mining units of 6-1/2 men each, mining rooms, 2 shifts per day.

A detailed study was made of one of the units developing entries. Entries 14 feet wide are driven in sets of 5 on 60-foot centers, and crosscuts 14 feet wide are driven on 70-foot centers. (See fig. 26.) In addition to the 13-man crew, the unit is comprised of: 1 roof-bolting machine, 1 mobile-loading machine, 1 universal cutting machine equipped with a hydraulic drill, 2 shuttle cars, 1 car hoist, and 1 rock-dusting machine. The roof-bolting and cutting machines are equipped with water sprays to allay the dust. Power to operate the mining equipment is furnished at 250 volts d.c.

The cycle of operation is: Roof-bolt, cut and drill, blast, and load coal.

Generated on 2024-09-21 14:49 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

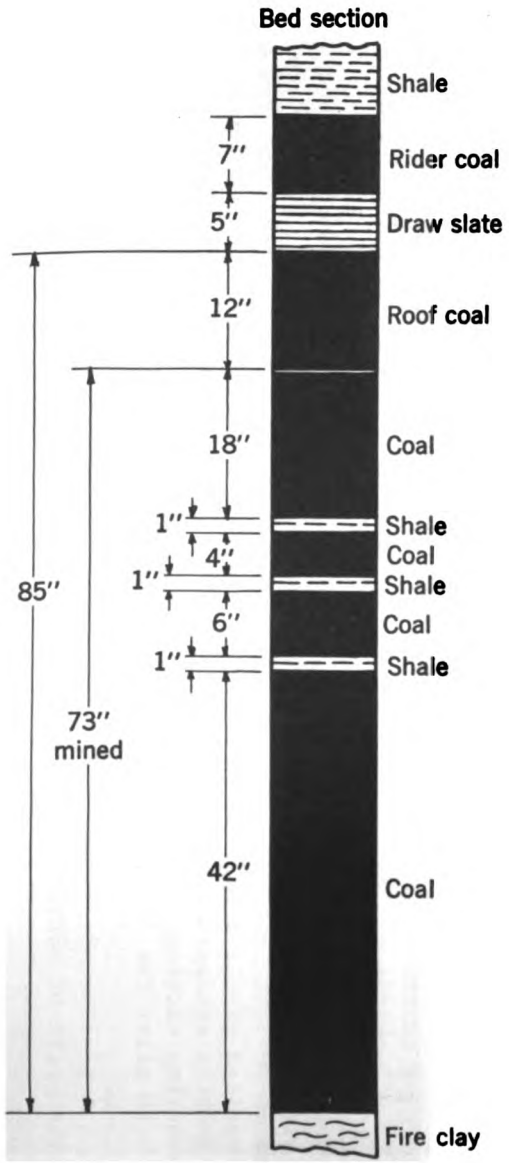

Figure 25. - Section of coal bed at mine 11.

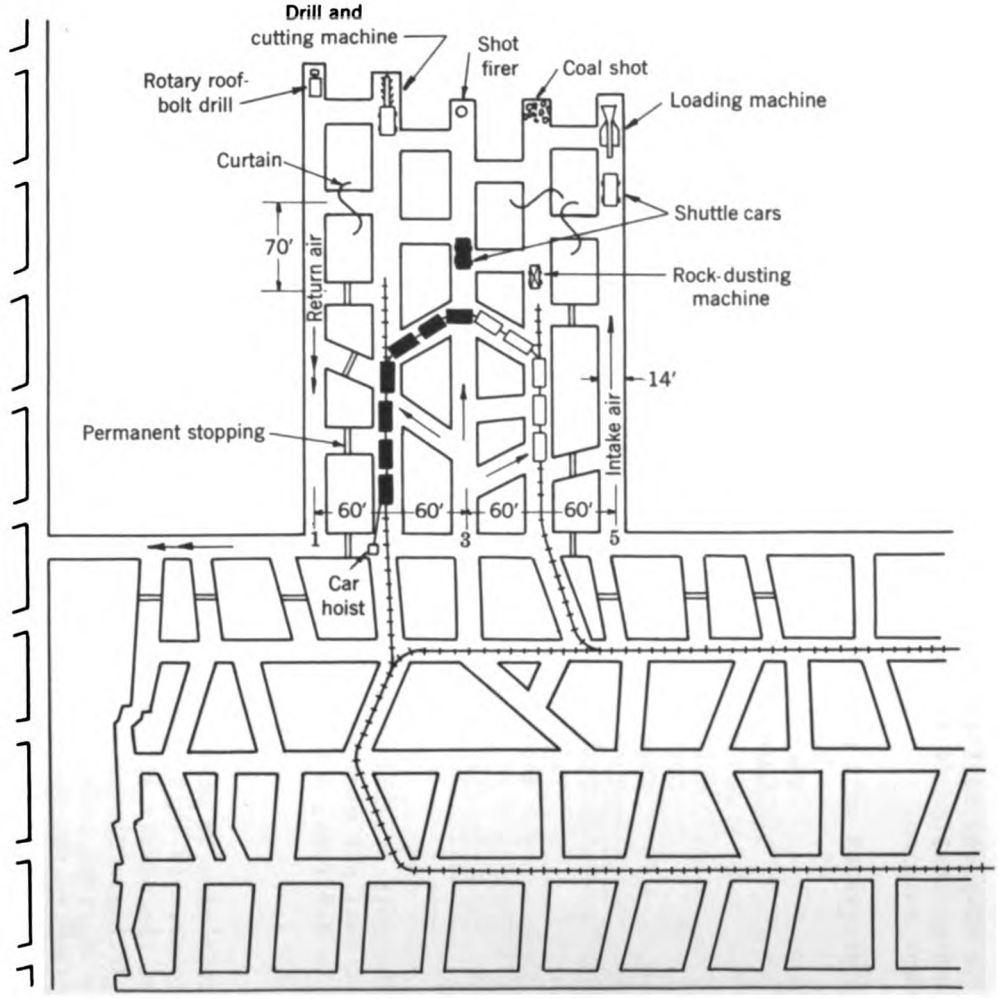

Figure 26. - Method of development at mine 11.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The roof is bolted on shift, using 3/4-inch expansion shells with bolts 5 feet long set against 6- by 6- by 1/4-inch steel bearing plates. The bolts are spaced 3 feet apart.

Entries are top-cut, leaving 8 to 12 inches of top coal, and sheared on the right side. Two holes 9 feet long are drilled by the cutting-machine crew near the bottom of the bed. Each hole is charged with five sticks of permissible explosive and blasted singly. Rock dusting is done by hand on shift and 2 to 3 times a week by machine.

The coal is loaded into 6-ton-capacity shuttle cars, transported to the unloading station, and dumped into 5.2-ton-capacity steel mine cars. Loaded cars are transported by 20- and 30-ton tandem locomotives to the shaft bottom, from where they are hoisted to the surface in self-dumping steel cages.

Sixty-pound steel fabricated track is laid in entries 2 and 4 of the section. The unloading station is established in entry 3 and advanced at 280-foot intervals as mining progresses.

A unit crew consists of the following men:

Section foreman	1
Loading-machine operator	1
Loading-machine operator's helper	1
Cutting-machine operator	1
Cutting-machine operator's helper	1
Shot firer	1
Roof bolters	2
Shuttle-car operators	2
Brattice man	1
Mechanic	1
General laborer	1
Total	13

The unit studied produces 393 tons of raw coal per shift, or 26.4 tons per man-shift. The average advance in each entry in a development group is 13.2 feet per shift, a total of 65.9 feet for the group.

Mine 12

This mine is operated in the Ohio No. 6 (Middle Kittanning) coal bed, which averages 80 inches in thickness in this area. (See fig. 27.) A bone coal parting 4 inches thick occurs 32 inches above the bottom of the bed. Clay veins and local rolls that dip up to 12° are encountered in mining. The coal is underlain by a hard, clayey shale and overlain by sandstone or sandy shale ranging from 15 to 25 feet in thickness. The overburden averages 630 feet in thickness and consists of sandstone, shales, claystones, and limestones.

This mine is operated 3 shifts daily and produces an average of 6,774 tons of raw coal (6,300 tons of clean coal) using the following units:

2 shuttle-car mobile-loading units developing main entries; 13 men each.
5 shuttle-car mobile-loading units developing panel entries and driving rooms; 13 men each.

Generated on 2024-09-21 14:54 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

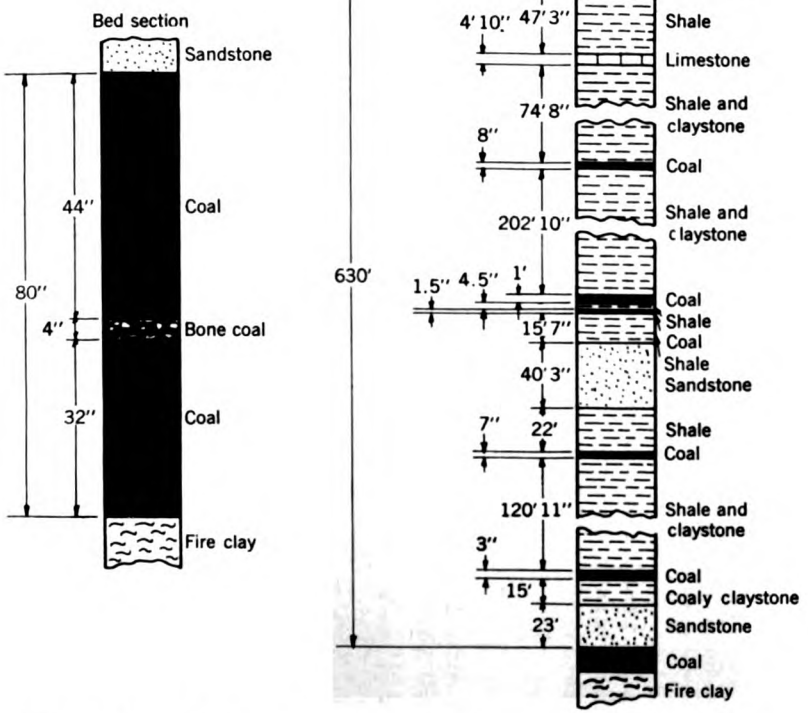

Figure 27. - Section of coal bed and overburden at mine 12.

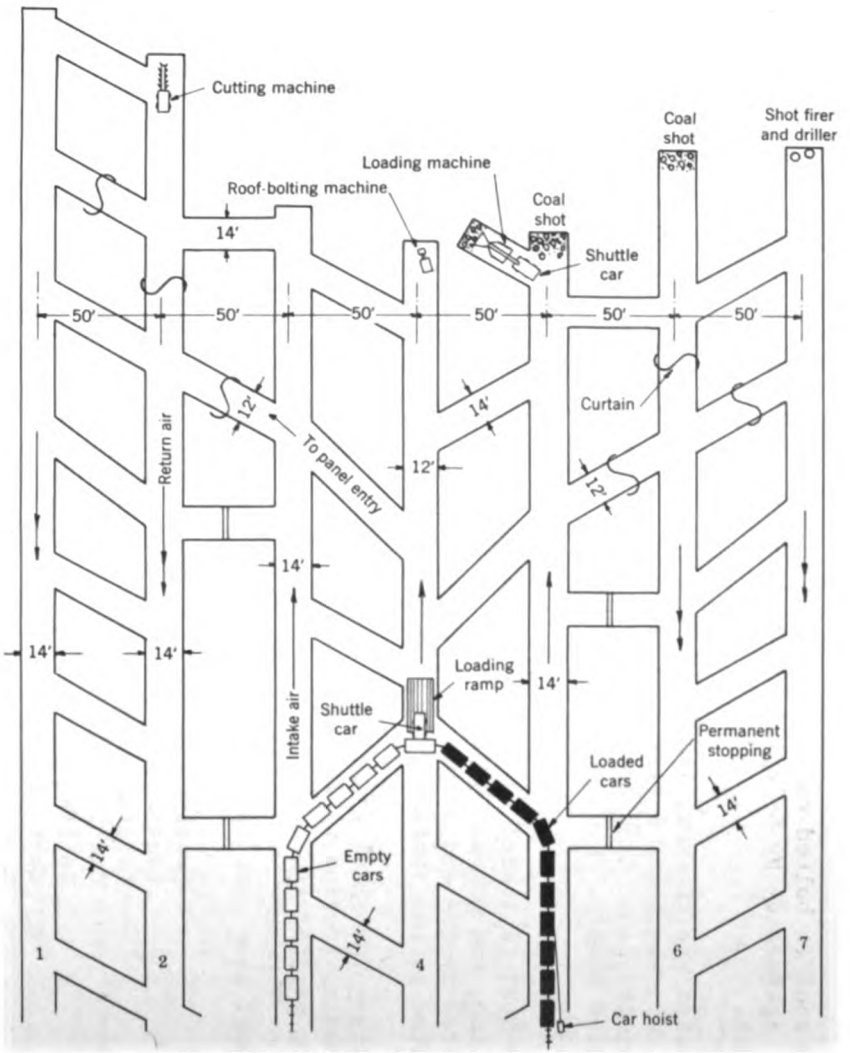

Figure 28. - Method of development at mine 12.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

A detailed study was made of 1 of the 13-man main-entry units. Main entries 12 and 14 feet wide are driven in sets of 7 on 50-foot centers. The middle or haulage entry is 12 feet wide, and others are 14 feet wide. Crosscuts are 12 feet wide where used for turning panel entries and 14 feet wide elsewhere. (See fig. 28.) These entries are developed by a unit consisting of 13 men, 1 mobile-loading machine, 1 universal cutting machine, 1 post-mounted drill, 1 roof-bolting machine, 2 shuttle cars, 1 car-spotter hoist, and 1 locomotive.

The cycle of operation is: Roof-bolt, drill, cut, blast, and load coal. Rock dusting is done on shift when required but usually between shifts with a machine. Power to operate the mining equipment is furnished at 275 volts d.c.

The roof is bolted with 5/8-inch expansion-shell-type bolts 42 inches long set against 4- by 4- by 1/8-inch steel bearing plates. The bolts are set 3-1/2 feet from the rib and spaced on 3-1/2-foot centers.

Two holes 8 feet long are drilled near the roof, one 18 inches from the left rib and the other in the center. Entries are bottom-cut and sheared on the right side to a depth of 8 feet. The rib hole is charged with 4 sticks and the center hole with 8 sticks of permissible explosive and blasted to break the coal. The coal is loaded by the loading machine into shuttle cars and transported to the loading ramp, where it is dumped into 4-ton-capacity steel mine cars. The remote-controlled car-spotter hoist is operated either by the shuttle-car operator or the motorman. The car-loading station is established every 260 feet of entry advance. Loaded cars are transported in 30-car trips to the shaft bottom and dumped, 2 cars at a time, into skips by a rotary dump. The coal is hoisted to the surface by 8-ton-capacity skips. The haulage track is 60-pound rail (48-inch gage) in the mains and 40-pound rail in the panel entries.

A unit crew consists of the following men:

Section foreman	1
Loading-machine operator	1
Loading-machine operator's helper	1
Cutting-machine operator	1
Cutting-machine operator's helper	1
Driller	1
Shot firer	1
Roof bolters	2
Shuttle-car operators	2
Mechanic	1
Motorman	1
Total	13

A unit crew produces 269 tons of raw coal per shift, or 20.7 tons per man-shift. The average advance in each entry is 7.0 feet per shift in a development group, a total advance of 49 feet for the group.

Mine 13

This mine is operated in the Pittsburgh bed, which averages 96 inches in thickness in this area. (See fig. 29.) Two shale partings, each 1 inch thick, occur 40 and 47 inches above the bottom of the bed. The top 10 to 12 inches of coal is left unmined to provide good roof. The coal is overlain with 10 inches of draw slate, above which is 10 inches of rider coal. Above the rider coal is shale 12 feet or

Generated on 2024-09-21 15:01 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-21 14:47 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

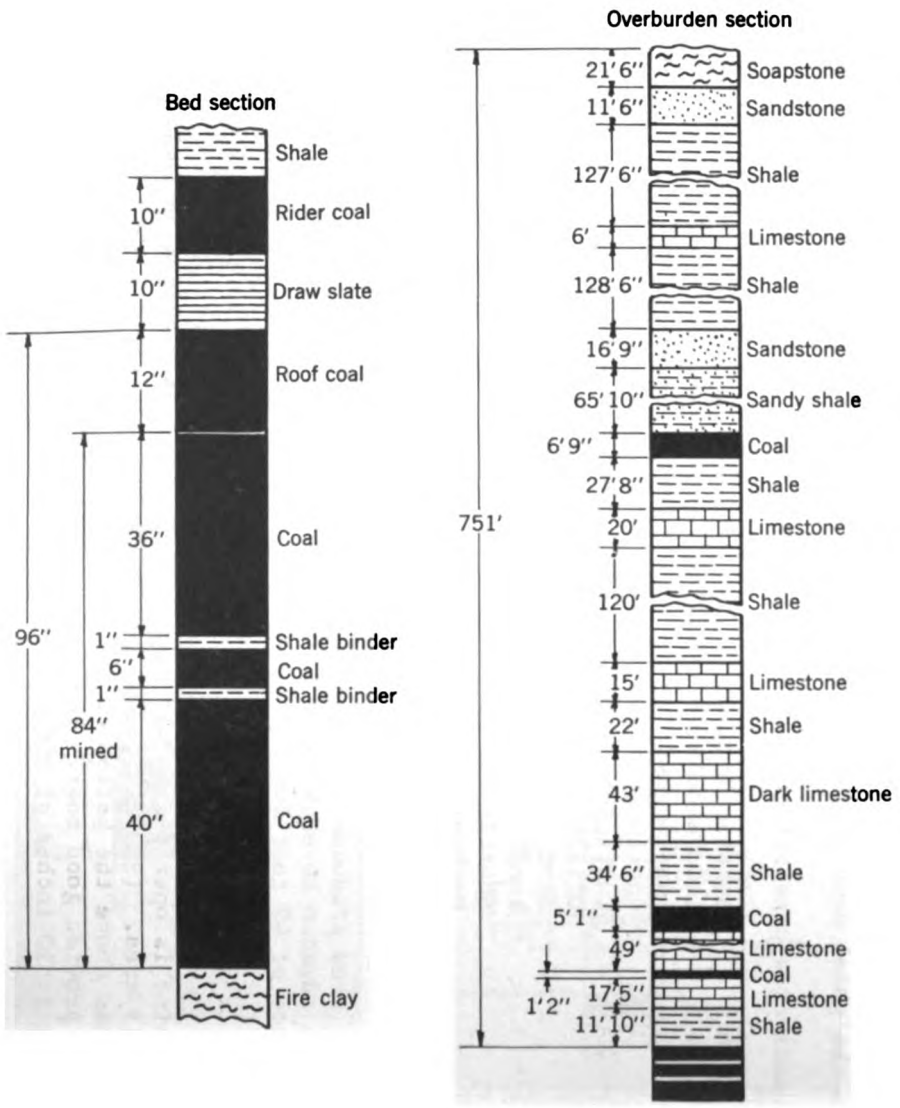

Figure 29. - Section of coal bed and overburden at mine 13.

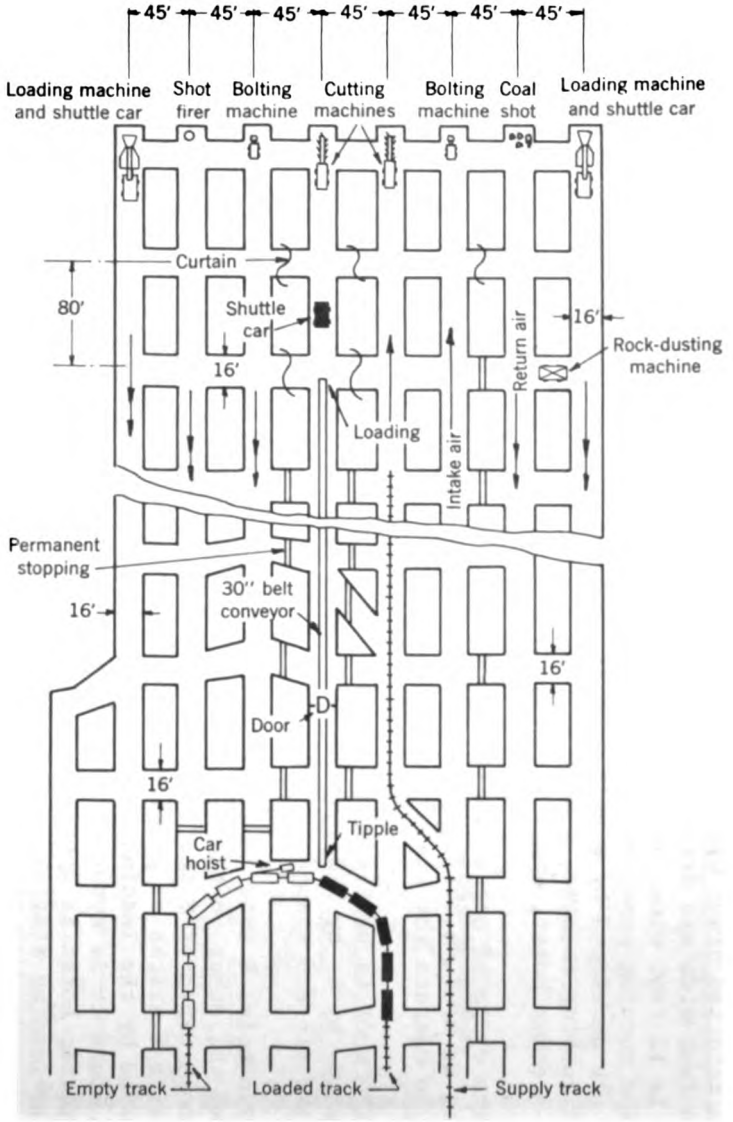

Figure 30. - Method of development at mine 13.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

more thick. The overburden consists mainly of shales, limestones, and sandstones and averages 751 feet in thickness.

The mine is operated 3 shifts per day and produces an average of 4,764 tons of raw coal (4,431 tons of clean coal) with the following units:

1 double mobile-loading unit developing entries; 19 facemen.
2 single mobile-loading units developing entries; 12 facemen each.

The 19-man entry-development unit was studied in detail. Main entries 16 feet wide are driven in sets of 8 on 45-foot centers, with crosscuts 16 feet wide on 80-foot centers. (See fig. 30.) These entries are developed by a double unit consisting of 19 men, 2 mobile-loading machines, 2 universal cutting machines, 2 handheld hydraulic drills, 2 roof-bolting machines, 3 shuttle cars, a 30-inch belt conveyor, 1 supply truck, 1 car hoist, and 1 rock-dusting machine. A spare loading machine also is kept on the section for emergency use.

The cycle of operation is: Roof-bolt and drill, cut, blast, and load coal. Power to operate all mining equipment is furnished at 550 volts d.c.

The roof is bolted on shift with 5/8-inch-diameter by 7-foot-long bolts with expansion shells. The bolts are set against 6- by 6- by 1/4-inch steel bearing plates and spaced 3 feet apart. Three holes are drilled 9 feet long in the coal near the bottom of the bed and spaced 3, 12, and 15 feet from the left rib. Each hole is charged with 6 or 7 sticks of permissible explosive and detonated 1 at a time. Rock dusting is done between shifts by machine.

Working places are top-cut, leaving 10 to 12 inches of top coal, and sheared on the left rib. The loading machine loads the coal into shuttle cars, which transport and discharge the coal onto the end of a 30-inch belt conveyor. The belt conveyor discharges the coal into 10-ton-capacity steel mine cars, which are transported to a rotary dump at the shaft bottom. Two 8-ton skips are used to hoist the coal to the surface.

Haulageways are equipped with 48-inch-gage track, with 80-pound rails. Track in other entries is laid with 40- and 60-pound rails. The belt conveyor and supply track are advanced at 80-foot intervals as mining progresses.

Rock dusting is done on shift by hand and between shifts by machine.

A double unit crew consists of the following men:

Section foreman	1
Loading-machine operators	2
Loading-machine operators' helpers	2
Cutting-machine operators	2
Cutting-machine operators' helpers	2
Shot firer	1
Roof bolters (also drillers)	4
Shuttle-car operators	3
Mechanic	1
Boom man	1
Total	19

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The unit crew produces an average of 804 tons of raw coal per shift or 39.4 tons per man-shift. The average advance in each entry in a development group is 16.2 feet per shift, a total advance of 129.7 feet for the group.

Mine 14

This mine is operated in the flat-lying Pittsburgh bed, which averages 96 inches in thickness in this area. (See fig. 31.) Three shale partings ranging from 1/2 to 1 inch in thickness occur 44, 49, and 52 inches above the bottom of the bed. Clay veins 2-1/2 feet or more in width are encountered in mining. The top 10 to 12 inches of coal is left unmined to provide good roof. The bed is underlain by a soft fire clay and overlain by 12 to 18 inches of draw slate. Above the draw slate is 1 inch or more of rider coal. The overburden consists mainly of shales and limestones and averages 140 feet in thickness.

The mine is operated 3 shifts per day and produces an average of 7,059 tons of raw coal (6,000 tons clean coal), using the following units:

2 double mobile-loading units developing entries; 21 facemen each.
1 single mobile-loading unit developing entries; 13 facemen.

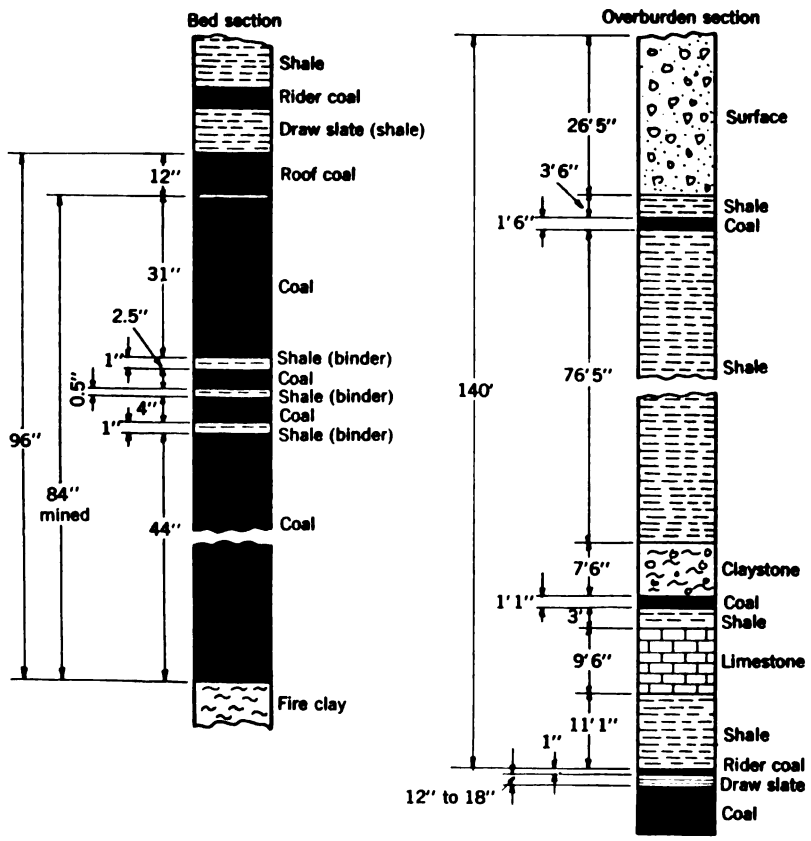

Figure 31. - Section of coal bed and overburden at mine 14.

Generated on 2024-09-21 14:50 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

A detailed study was made of one of the double mobile-loading shuttle-car units. Entries 16 feet wide are driven in sets of 10 on 45-foot centers, with crosscuts 16 feet wide on 80- and 90-foot centers. (See fig. 32.) These entries are developed by a double unit, consisting of 21 men, 2 mobile-loading machines, 2 universal cutting machines, 2 handheld hydraulic drills (1 on each cutting machine), 4 shuttle cars, 2 rock-dusting machines, and 1 car-spotter hoist.

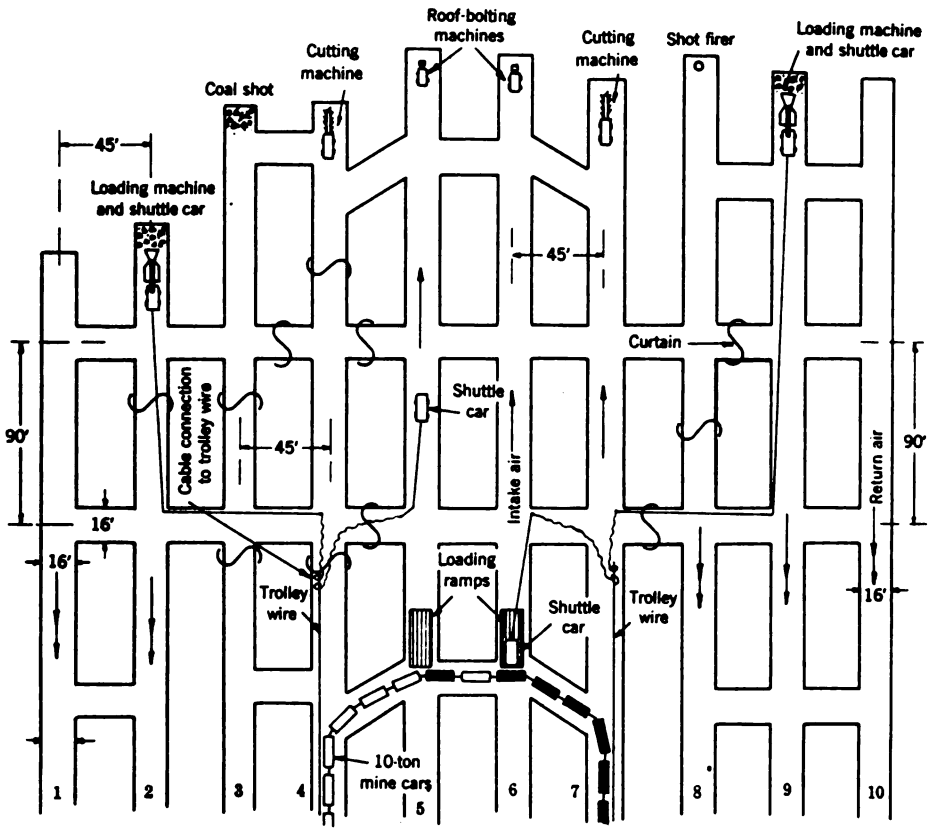

Figure 32. - Method of development at mine 14.

The cycle of operation is: Roof-bolt, cut and drill, blast, and load coal. Power to operate the equipment is furnished at 250 volts d.c.

Entries are roof-bolted with 3/4-inch by 4-foot-long bolts, with expansion shells. The bolts are set against 6- by 6- by 1/4-inch steel bearing plates and spaced 3 feet apart.

All entries except the number 4 or track entry are top-cut and sheared on the right rib, leaving 10 to 12 inches of top coal. The number 4 or track entry is top-cut and sheared on both ribs. Three holes are drilled 9 feet long in the coal near the bottom of the bed by the cutting-machine crew and spaced 2-1/2, 7-1/2, and 12-1/2 feet from the left rib. Each hole is charged with five sticks of permissible explosive and detonated one hole at a time. Rock dusting is done by machine on or between shifts, as required.

The coal is loaded into 6-ton shuttle cars, transported to the unloading stations, and dumped into 10-ton-capacity steel mine cars. Loaded cars are transported

Generated on 2024-09-21 14:47 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

over 80-pound rail (42-inch track gage) to the rotary dump at the slope bottom. The slope, 280 feet long on a dip of 16°, is equipped with a 48-inch belt conveyor for transporting the coal to the cleaning plant on the surface, a supply track, and a manway equipped with ski-rope hoist (handheld) to assist the men walking up the slope to the surface.

The panel-track and unloading station are advanced at 260-foot intervals as mining progresses.

A double unit crew consists of the following men:

Section foreman	1
Loading-machine operators	2
Loading-machine operators' helpers	2
Cutting-machine operators (also drillers)	2
Cutting-machine operators' helpers (also drillers)	2
Roof bolters	4
Shot firer	1
Mechanic	1
Shuttle-car operators	4
Brattice man	1
Car-hoist operator	1
Total	21

The unit crew produces 890 tons of raw coal per shift or 42.4 tons per man-shift. The average advance in each entry in a development group is 13.1 feet per shift, a total of 130.9 feet for the group.

CONCLUSIONS

From development studies at 14 mines, the following conclusions have been drawn:

1. Modern development methods permit close supervision because of proximity of working places. Efficient use of machinery is possible, because long moves of equipment are unnecessary to keep development places of the unit advancing.

2. Unit crews are comprised of men who can operate each piece of equipment and thereby work as a team.

3. As the width of development opening approaches that of a production place, the closer becomes the output, in tons per man-shift, between the two types of mining.

4. As the degree of mechanization increases in development, the less becomes the difference in output between production and development.

Generated on 2024-09-21 14:55 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

APPENDIX I

Classification of Mine Employees

Classification of Mine 1 Employees

Classification	Shift 1st	2d	3d	Total
Mobile-loading piggyback units in entries:				
Section foremen	2	2	-	4
Loading-machine operators	2	2	-	4
Loading-machine operators' helpers	2	2	-	4
Cutting-machine operators	2	2	-	4
Cutting-machine operators' helpers	2	2	-	4
Pan movers (conveyor men)	2	2	-	4
Timbermen	2	2	-	4
Utility men	2	2	-	4
Boom men	2	2	-	4
Total	18	18	-	36
Other employees, mobile-loading piggyback units in rooms	9	9	-	18
Supervisory and inspection	4	3	1	8
Other underground employees	17	8	8	33
Total underground employees	48	38	9	95
Total surface employees	14	9	2	25
Total surface and underground employees	62	47	11	120

Classification of Mine 2 Employees

Classification	Shift 1st	2d	3d	Total
Hand-loading onto chain conveyors, entry development:				
Section foreman	1	-	-	1
Cutting-machine operators	2	-	-	2
Cutting-machine operators' helpers	2	-	-	2
Timbermen	2	-	-	2
Supply man	1	-	-	1
Boom man	1	-	-	1
Total	9	-	-	9
Total employees hand loading onto chain-conveyor units in rooms	24	24	-	48
Duckbill unit in rooms	9	9	-	18
Mobile-loading, chain-conveyor units	30	30	-	60
Supervisory and inspection	3	1	2	6
Other underground employees	30-1/2	13-1/2	1	45
Total underground employees	105-1/2	77-1/2	3	186
Total surface employees	24	2	6	26
Total surface and underground employees	129-1/2	79-1/2	3	212

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Classification of Mine 3 Employees

Classification	Shift 1st	2d	3d	Total
Hand loading onto chain conveyors in entries:				
Section foreman	1/2	1/2	-	1
Facemen	12	12	-	24
Total (No. 2 mine)	12-1/2	12-1/2	-	25
Total employees hand loading onto chain conveyors in rooms (No. 2 mine)	6-1/2	4-1/2	-	11
Total employees hand loading into mine cars (No. 1 mine)	35	12	-	47
Supervisory and inspection (No. 2 mine)	-	-	1	1
Supervisory and inspection (No. 1 mine)	2	2	-	4
Other underground employees (No. 2 mine)	4	3	3	10
Other underground employees (No. 1 mine)	14	5	-	19
Total underground employees	74	39	4	117
Total surface employees (No. 2 mine)	7	2	-	9
Total surface employees (No. 1 mine)	6	1	-	7
Total surface and underground employees, both mines	87	42	4	133

Classification of Mine 4 Employees

Classification	Shift 1st	2d	3d	Total
Conveyor-mobile loading (development unit studied):				
Section foreman	3/4	1/4	-	1
Loading-machine operators	3	3	-	6
Cutting-machine operators	3	3	-	6
Scrapers	3	3	-	6
Oilers	3/4	3/4	-	1-1/2
Boom men	3/4	3/4	-	1-1/2
Total	11-1/4	10-3/4	-	22
Other employees, conveyor mobile-loading units	15-1/2	15-1/2	-	31
Total employees in hand-loading units	8	8	-	16
Supervisory and inspection	1	-	-	1
Other underground employees	6	1	8	15
Total underground employees	41-3/4	35-1/4	8	85
Total surface employees	14	1	1	16
Total surface and underground employees	55-3/4	36-1/4	9	101

Generated on 2024-09-21 14:47 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Classification of Mine 5 Employees

Classification	Shift 1st	2d	3d	Total
Hand loading onto shaker conveyors in entries:				
Section foreman	1/2	1/2	-	1
Drillers	2	2	-	4
Cutting-machine operators	2	2	-	4
Shot firers	2	2	-	4
Hand loaders	2	2	-	4
Total	8-1/2	8-1/2	-	17
Total employees, hand loading onto shaker conveyors in rooms	11	11	6	28
Total employees on mobile-loading units in entries and rooms	19-1/4	19-1/4	10	48-1/2
Total employees, hand loading into mine cars in rooms	31	36	-	67
Supervisory and inspection	6-1/4	4-1/4	2	12-1/2
Other underground employees	40	21	14	75
Total underground employees	116	100	32	248
Total surface employees	38	13	3	54
Total surface and underground employees	154	113	35	302

Classification of Mine 6 Employees

Classification	Shift 1st	2d	3d	Total
Mobile-loading units in entry:				
Section foremen	1	1	-	2
Loading-machine operators	1	1	-	2
Loading-machine operators' helpers	1	1	-	2
Cutting-machine operators	1	1	-	2
Cutting-machine operators' helpers	1	1	-	2
Drillers	2	2	-	4
Shot firers	1	1	-	2
Shuttle-car operators	2	2	-	4
Mechanics	1	1	-	2
Clean-up men	1	1	-	2
Total	12	12	-	24
Mobile-loading units in rooms	36	36	-	72
Supervisory and inspection	11	1	1	13
Other underground employees	38	14	12	54
Total underground employees	87	63	13	163
Total surface employees	14	6	-	20
Total surface and underground employees	101	69	13	183

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Classification of Mine 7 Employees

Classification	Shift 1st	Shift 2d	Shift 3d	Total
Continuous-mining units:				
Section foremen	2	2	-	4
Continuous-mining-machine operators	2	2	-	4
Continuous-mining-machine operators' helpers	2	2	-	4
Loading-machine operators	2	2	-	4
Loading-machine operators' helpers	2	2	-	4
Supply men	2	2	-	4
Mechanics	2	2	-	4
Total	14	14	-	28
Mobile-loading piggyback chain-conveyor units	41	41	13	95
Mobile-loading shuttle-car units	27	27	-	54
Supervisory and inspection	4	3	3	10
Other underground employees	28	7	20	55
Total underground employees	114	92	36	242
Total surface employees	26	16	5	47
Total surface and underground employees	140	108	41	289

Classification of Mine 8 Employees

Classification	Shift 1st	Shift 2d	Shift 3d	Total
Mobile loading to shuttle cars:				
Section foremen	1	1	-	2
Loading-machine operators	2	2	-	4
Loading-machine operators' helpers	2	2	-	4
Cutting-machine operators	2	2	-	4
Cutting-machine operators' helpers	2	2	-	4
Shuttle-car operators	3	3	-	6
Total	12	12	-	24
Total employees, piggyback units	6	6	-	12
Supervisory and inspection	-	-	1	1
Other underground employees	5	2	7	14
Total underground employees	23	20	8	51
Total surface employees	11	1	-	12
Total surface and underground employees	34	21	8	63

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Classification of Mine 9 Employees

Classification	Shift 1st	Shift 2d	Shift 3d	Total
Track-loading units (9-man crews):				
Section foremen	6	6	-	12
Loading-machine operators	6	6	-	12
Loading-machine operators' helpers	6	6	-	12
Cutting-machine operators	6	6	-	12
Cutting-machine operators' helpers	6	6	-	12
Shot firers	6	6	-	12
Roof bolters	1	1	-	2
Timbermen	6	6	-	12
Mechanics	1-1/2	1-1/2	-	3
Motormen	6	6	-	12
Brakemen	6	6	-	12
Total	56-1/2	56-1/2	-	113
Mobile-loading units on rock (and coal)	10-1/2	10-1/2	19	40
Supervisory and inspection	4	2	2	8
Other underground employees	20	13	22	55
Total underground employees	91	82	43	216
Total surface employees	10	8	1	19
Total surface and underground employees	101	90	44	235

Classification of Mine 10 Employees

Classification	Shift 1st	Shift 2d	Shift 3d	Total
Mobile-loading, piggyback conveyor unit:				
Section foremen	1	1	-	2
Loading-machine operators	1	1	-	2
Loading-machine operators' helpers	1	1	-	2
Cutting-machine operators	1	1	-	2
Cutting-machine operators' helpers	1	1	-	2
Shot firers	1	1	-	2
Roof bolters	2	2	-	4
Timbermen	1	1	-	2
Pan movers (conveyor men)	2	2	-	4
Boom men	1	1	-	2
Total	12	12	-	24
Mobile-loading, shuttle-car units, in entries	24	24	-	48
Mobile-loading, shuttle-car units, in rooms	22	22	-	44
Mobile-loading, shuttle-car units, in pillars	14	-	-	14
Supervisory and inspection	2	1	1	4
Other underground employees	35	37	29	101
Total underground employees	109	96	30	235
Total surface employees	37	36	2	75
Total surface and underground employees	146	132	32	310

Generated on 2024-09-21 14:57 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Classification of Mine 11 Employees

Classification	Shift 1st	2d	3d	Total
Mobile-loading units:				
Section foremen	5	5	1	11
Loading-machine operators	5	5	1	11
Loading-machine operators' helpers	5	5	1	11
Cutting-machine operators	5	5	1	11
Cutting-machine operators' helpers	5	5	1	11
Shot firers	5	5	1	11
Roof bolters	10	10	2	22
Shuttle-car operators	10	10	2	22
Brattice men	5	5	1	11
Mechanics	5	5	1	11
General laborers	5	5	1	11
Total	65	65	13	143
Continuous-mining units	13	13	-	26
Supervisory and inspection	3	4	2	9
Other underground employees	52	18	23	93
Total underground employees	133	100	38	271
Total surface employees	40	21	13	74
Total surface and underground employees	173	121	51	345

Classification of Mine 12 Employees

Classification	Shift 1st	2d	3d	Total
Mobile-loading units, main entries:				
Section foremen	2	2	2	6
Loading-machine operators	2	2	2	6
Loading-machine operators' helpers	2	2	2	6
Cutting-machine operators	2	2	2	6
Cutting-machine operators' helpers	2	2	2	6
Drillers	2	2	2	6
Shot firers	2	2	2	6
Roof bolters	4	4	4	12
Shuttle-car operators	4	4	4	12
Mechanics	2	2	2	6
Motormen	2	2	2	6
Total	26	26	26	78
Mobile-loading units, panel entries and rooms	65	65	65	195
Supervisory and inspection	6	1	1	8
Other underground employees	85	21	21	127
Total underground employees	182	113	113	408
Total surface employees	42	33	33	108
Total surface and underground employees	224	146	146	516

Generated on 2024-09-21 14:55 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Classification of Mine 13 Employees

Classification	Shift 1st	2d	3d	Total
Mobile-loading, double unit:				
Section foremen	1	1	1	3
Loading-machine operators	2	2	2	6
Loading-machine operators' helpers	2	2	2	6
Cutting-machine operators	2	2	2	6
Cutting-machine operators' helpers	2	2	2	6
Shot firers	1	1	1	3
Roof bolters (also drillers)	4	4	4	12
Shuttle-car operators	3	3	3	9
Mechanics	1	1	1	3
Boom men	1	1	1	3
Total	19	19	19	57
Total employees, mobile-loading, single units	24	24	24	72
Supervisory and inspection	6	6	5	17
Other underground employees	30	24	22	76
Total underground employees	79	73	70	222
Total surface employees	15	15	3	33
Total surface and underground employees	94	88	73	255

Classification of Mine 14 Employees

Classification	Shift 1st	2d	3d	Total
Mobile-loading, double units:				
Section foremen	2	2	2	6
Loading-machine operators	4	4	4	12
Loading-machine operators' helpers	4	4	4	12
Cutting-machine operators (also drillers)	4	4	4	12
Cutting-machine operators; helpers (also drillers)	4	4	4	12
Roof bolters	8	8	8	24
Shot firers	2	2	2	6
Shuttle-car operators	8	8	8	24
Mechanics	2	2	2	6
Brattice men	2	2	2	6
Car-hoist operators	2	2	2	6
Total	42	42	42	126
Total employees, mobile-loading, single unit	14	14	14	42
Supervisory and inspection	3	1	2	6
Other underground employees	58	13	12	83
Total underground employees	117	70	70	257
Total surface employees	27	12	11	50
Total surface and underground employees	114	82	81	307

Generated on 2024-09-21 15:00 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary of Data for Mines Studied

Summary, Mine 1

Coal bed		No. 3 Elkhorn
Thickness of bed	inches	35
Thickness mined	do.	35

		Mobile loading onto piggybacks to chain conveyors	
		Entries	Rooms
Percent of mine production		56	44
Hours per shift		8	8
Number of units		2	1
Unit shifts per day		4	2
Average yield of clean coal	percent	98	98
Average width of place	feet	30	40
Number of places in set		4	2
Average advance of working place per shift	feet	10.8	23
Average advance of working place, including crosscuts, per shift	do.	14.0	27
Employees:			
In unit crews		36	18
Supervisory and other underground[1/]		23	18
Total underground		59	36
Surface[1/]		14	11
Total charged to		73	47
Average daily production, raw coal	tons	600	470
Average production per unit per shift, raw coal	do.	150	235
Average production per man-shift in unit crew, raw coal	do.	16.7	26.1
Average production per underground man-shift, raw coal	do.	10.2	13.1
Average production per payroll man-shift, raw coal	do.	8.2	10.0

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 2

Coal bed		Pocahontas No. 3
Thickness of bed	inches	36
Thickness mined	do.	36
Coal bed		Pocahontas No. 4
Thickness of bed	inches	42
Thickness mined	do.	42

	Hand loading to chain conveyors		Duckbill loading to conveyor	Mobile loading to chain conveyors
	Entries	Rooms	Rooms	Entries and rooms
Bed	No. 3	No. 4	No. 4	No. 4
Percent of mine production	6.5	33.8	18.0	41.7
Hours per shift	8	8	8	8
Number of units	1	2	1	2
Unit shifts per day	1	4	2	4
Average yield of clean coal, percent	89	89	89	89
Average width of place, feet	20	40	40	20 and 40
Number of places in set	6	-	-	3
Average advance of working place per shift, feet	6.1	-	-	1/ 12.7
Average advance of working place, including crosscuts, per shift, feet	7.3	-	-	1/ 15.2
Employees:				
In unit crews	9	48	18	60
Supervisory and other underground 2/	3	17	10	21
Total underground	12	65	28	81
Surface 2/	1	9	5	11
Total charged to	13	74	33	92
Average daily production, raw coal, tons	98	510	272	630
Average production per unit per shift, raw coal, do.	98	127.5	136	157.5
Average production per man-shift in unit crew, raw coal, do.	10.9	10.6	15.1	10.5
Average production per underground man-shift, raw coal, do.	8.2	7.8	9.7	7.8
Average production per payroll man-shift, raw coal, do.	7.5	6.9	8.2	6.8

1/ Combined advance of entries and rooms.
2/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:55 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 3

Coal bed	Pocahontas No. 3
Thickness of bed, inches	40
Thickness mined, do.	40

	Mine 2		Mine 1	
	Hand loading to chain conveyors		Hand loading to mine cars	
	Entries	Rooms	Entries	Rooms
Percent of mine production	32.4	16.5	11.8	39.3
Hours per shift	8	8	8	8
Number of units	1	1	1	1
Unit shifts per day	2	2	1	1
Average yield of clean coal, percent	85	85	85	85
Average width of place, feet	24	40	24	24
Number of places in set	6	3 - 2	7	-
Average advance of working place per shift, feet	5.4	3.3	-	-
Average advance of working place, including crosscuts, per shift, do.	8.2	3.5	-	-
Employees:				
In unit crews	25	11	12	35
Supervisory and other underground 1/	7	4	5	18
Total underground	32	15	17	53
Surface 1/	6	3	2	5
Total charged to	38	18	19	58
Average daily production, raw coal, tons	312	159	114	378
Average production per unit per shift, raw coal, do.	156	79.5	114	378
Average production per man-shift in unit crew, raw coal, do.	12.5	14.5	9.5	10.8
Average production per underground man-shift, raw coal, do.	9.8	10.6	6.7	7.1
Average production per payroll man-shift, raw coal, do.	8.2	8.8	6.0	6.5

1/ Number of men prorated in each mine in proportion to average daily production.

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 4

Coal bed ..... Lower Kittanning (B)

Thickness of bed ..... inches 42

Thickness mined ..... do. 38

	Mobile loading to shaker conveyor		Hand loading to shaker conveyor
	Entries	Rooms, pillars, and entries	Rooms
Percent of mine production	36.4	38.6	25.0
Hours per shift	8	8	8
Number of units	1	2	2
Unit shifts per day	2	4	4
Average yield of clean coal, percent	88	88	88
Average width of place, feet	20	25	25
Number of places in set	3	-	-
Average advance of working place per shift, feet	10.2	9.0	8.9
Average advance of working place, including crosscuts, per shift, do.	14.4	12.0	11.9
Employees:			
In unit crews	22	31	16
Supervisory and other underground[1/]	6	6	4
Total underground	28	37	20
Surface[1/]	6	6	4
Total charged to	34	43	24
Average daily production, raw coal, tons	228	242	157
Average production per unit per shift, raw coal, do.	114	60.5	39.3
Average production per man-shift in unit crew, raw coal, do.	10.4	7.8	9.8
Average production per underground man-shift, raw coal, do.	8.1	6.5	7.9
Average production per payroll man-shift, raw coal, do.	6.7	5.6	6.5

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 5

Coal bed ..... Lower Kittanning (B)

Thickness of bed ..... inches 75

Thickness mined ..... do. 43

	Hand loading to shaker conveyor		Mobile loading to shuttle cars		Hand loading to mine cars
	Entries	Rooms	Main entry	Rooms and pillars	Rooms
Percent of mine production	10.9	17.9	5.5	44.0	21.7
Hours per shift	8	8	8	8	8
Number of units	2	2	1	3	1
Unit shifts per day	4	5	2	8	-
Average yield of clean coal .... percent	100	100	100	100	100
Average width of place ..... feet	15	20	15	20	20
Number of places in set	3	-	7	-	-
Average advance of working place per shift ..... feet	5.0	-	-	20.4	-
Average advance of working place, including crosscuts, per shift ... do.	6.4	-	-	24.9	-
Employees:					
In unit crews	17	28	8-1/2	40	67
Supervisory and other underground[1/] ...	9-1/2	15-1/2	4-3/4	38-1/2	19-1/4
Total underground	26-1/2	43-1/2	13-1/4	78-1/2	86-1/4
Surface[1/]	6	9-1/2	3	23-3/4	11-3/4
Total charged to	32-1/2	53	16-1/4	102-1/4	98
Average daily production, raw coal..tons	230	377	115	928	457
Average production per unit per shift, raw coal ..... do.	57.5	75.4	57.5	116.0	228.5
Average production per man-shift in unit crew, raw coal ..... do.	13.5	13.5	13.5	23.2	6.8
Average production per underground man-shift, raw coal ..... do.	8.7	8.7	8.7	11.8	5.3
Average production per payroll man-shift, raw coal ..... do.	7.1	7.1	7.1	9.1	4.7

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 7

Coal bed		Middle Kittanning
Thickness of bed	inches	46
Thickness mined	do.	46

		Mobile loading	
		Entries	Rooms
Percent of mine production		21.4	78.6
Hours per shift		8	8
Number of units		1	3
Unit shifts per day		2	6
Average yield of clean coal	percent	90	90
Average width of place	feet	16	23
Number of places in set		4	4
Average advance of working place, including room necks, per shift	feet	22.0	18.4
Average advance of working place, including room necks and crosscuts, per shift	do.	28.4	21.4
Employees:			
In unit crews		24	72
Supervisory and other underground[1/]		14	53
Total underground		38	125
Surface[1/]		4	16
Total charged to		42	141
Average daily production, raw coal	tons	606	2,226
Average production per unit per shift, raw coal	do.	303	371
Average production per man-shift in unit crew, raw coal	do.	25.3	30.9
Average production per underground man-shift, raw coal	do.	15.9	17.8
Average production per payroll man-shift, raw coal	do.	14.4	15.8

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 7

Coal bed ..... Sewell

Thickness of bed ..... inches 46

Thickness mined ..... do. 46

	Continuous mining		Mobile loading: Piggyback chain conveyors		Mobile loading: Shuttle cars	
	Entries	Rooms	Entries	Rooms	Entries	Rooms
Percent of mine production	16.5	16.3	31.3	9.8	19.2	6.9
Hours per shift	8	8	8	8	8	8
Number of units	1	1	1/ 4 or 5	1/ 1 or 2	2	1
Unit shifts per day	2	2	11	3	4	2
Average yield of clean coal ..... percent	95	95	95	95	95	95
Average width of place ..... feet	27	27	25	25	25	25
Number of places or rooms in set	9	2	4	3 and 4	9	2
Average advance of working place per shift ..... feet	6.1	27.0	-	-	-	-
Average advance of working place, including cross-cuts, per shift ..... do.	8.7	39.6	-	-	-	-
Employees:						
In unit crews	14	14	74	21	40	14
Supervisory and other underground 2/	11	11	20	6	12	5
Total underground	25	25	94	27	52	19
Surface 2/	8	8	15	4	9	3
Total charged to	33	33	109	31	61	22
Average daily production, raw coal ..... tons	599	592	1,140	357	700	250
Average production per unit per shift, raw coal ..... do.	299.5	296	104	119	175	125
Average production per man-shift in unit crew, raw coal ..... do.	42.8	42.3	15.4	17.0	17.5	17.9
Average production per underground man-shift, raw coal. do.	24.0	23.7	12.1	13.2	13.5	13.2
Average production per payroll man-shift, raw coal... do.	18.2	17.9	10.5	11.5	11.5	11.4

1/ Part of 7-man units work both rooms and entries, giving an average of 3 unit shifts per day in rooms.

2/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 8

Coal bed	Coalburg
Thickness of bed, inches	73
Thickness mined, do.	55

	Mobile loading to shuttle cars, Entries	Mobile loading to piggybacks to chain conveyors, Rooms
Percent of mine production	66.1	33.9
Hours per shift	8	8
Number of units	1	1
Unit shifts per day	2	2
Average yield of clean coal, percent	89.3	89.3
Average width of place, feet	20	40
Number of places or rooms in set	6	2
Average advance of working place per shift, feet	18.2	17.4
Average advance of working place, including crosscuts, per shift, do.	23.3	19.9
Employees:		
In unit crews	24	12
Supervisory and other underground[1/]	10	5
Total underground	34	17
Surface[1/]	8	4
Total charged to	42	21
Average daily production, raw coal, tons	1,019	522
Average production per unit per shift, raw coal, do.	509.5	261
Average production per man-shift in unit crew, raw coal, do.	42.5	43.5
Average production per underground man-shift, raw coal, do.	30.0	30.7
Average production per payroll man-shift, raw coal, do.	24.3	24.9

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 9

Coal bed ..... Upper Kittanning (C')

Thickness of bed ..... inches 59

Thickness mined ..... do. 59

		Mobile loading	
		Entries	Rock and coal
Percent of mine production		84.6	15.4
Hours per shift		8	8
Number of units		6	2
Unit shifts per day		12	6
Average yield of clean coal	percent	80	80
Average width of place	feet	14 and 19	14 and 19
Number of places in set		5	5
Average advance of working place per shift	feet	6.1	-
Average advance of working place, including crosscuts, per shift	do.	8.6	-
Employees:			
In unit crews		113	40
Supervisory and other underground[1/]		53	10
Total underground		166	50
Surface[1/]		16	3
Total charged to		182	53
Average daily production, raw coal	tons	1,608	292
Average production per unit per shift, raw coal	do.	134.0	48.7
Average production per man-shift in unit crew, raw coal	do.	14.2	7.3
Average production per underground man-shift, raw coal	do.	9.7	5.8
Average production per payroll man-shift, raw coal	do.	8.8	5.1

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:54 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 10

Coal bed ..... Leatherwood
Thickness of bed ..... inches 41 to 65

	Mobile loading			
	Piggybacks	Shuttle cars		
	Entries	Entries	Rooms	Pillars
Thickness mined ..... inches	65	41	65	65
Percent of mine production	19.9	35.1	34.3	10.7
Hours per shift	8	8	8	8
Number of units	1	2	2	1
Unit shifts per day	2	4	1/ 4	1/ 1
Average yield of clean coal ..... percent	87	87	87	87
Average width of place ..... feet	25	20	20	-
Number of places in set	6	5	5	-
Average advance of working place per shift ..... feet	8.9	14	14.8	-
Average advance of working place, including crosscuts, per shift ..... do.	12.4	20.8	22.0	-
Employees:				
In unit crews	24	48	44	14
Supervisory and other underground 2/	21	37	36	11
Total underground	45	85	80	25
Surface 2/	15	26	26	8
Total charged to	60	111	106	33
Average daily production, raw coal ..... tons	937	1,653	1,616	504
Average production per unit per shift, raw coal ..... do.	468	413	404	504
Average production per man-shift in unit crew, raw coal ..... do.	39.0	34.4	36.7	36.0
Average production per underground man-shift, raw coal ..... do.	20.8	19.4	20.2	20.2
Average production per payroll man-shift, raw coal ..... do.	15.6	14.9	15.2	15.3

1/ Unit shifts and size of crew vary with type of mining.
2/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 11

Coal bed		Pittsburgh
Thickness of bed	inches	85
Thickness mined	do.	73

		Mobile loading Entries	Continuous mining Rooms
Percent of mine production		79	21
Hours per shift		8	8
Number of units		5	2
Unit shifts per day		11	4
Average yield of clean coal	percent	92	92
Average width of place	feet	14	16
Number of places or rooms in set		5	2
Average advance of working place per shift, unit studied	feet	13.2	22
Average advance of working place, including crosscuts, per shift	do.	20.8	25
Employees:			
In unit crews		143	26
Supervisory and other underground[1/]		81	21
Total underground		224	47
Surface[1/]		58	16
Total charged to		282	63
Average daily production, raw coal	tons	3,779	1,004
Average production per unit per shift, raw coal	do.	343.5	251
Average production per shift, unit studied, raw coal	do.	393	-
Average production per man-shift in unit crew, raw coal	do.	26.4	38.6
Average production per underground man-shift, raw coal	do.	16.9	21.4
Average production per payroll man-shift, raw coal	do.	13.4	15.9

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 12

Coal bed		No. 6
Thickness of bed	inches	80
Thickness mined	do.	80

		Mobile loading Entries	Mobile loading Rooms
Percent of mine production		23.8	76.2
Hours per shift		8	8
Number of units		2	5
Unit shifts per day		6	15
Average yield of clean coal	percent	93	93
Average width of place	feet	14	24
Number of places or rooms in set		7	5
Average advance of working place per shift	feet	7.0	11.9
Average advance of working place, including crosscuts, per shift	do.	10.4	13.9
Employees:			
In unit crews		78	195
Supervisory and other underground 1/		32	103
Total underground		110	298
Surface 1/		26	82
Total charged to		136	380
Average daily production, raw coal	tons	1,614	5,160
Average production per unit per shift, raw coal	do.	269	344
Average production per man-shift in unit, raw coal	do.	20.7	26.5
Average production per underground man-shift, raw coal	do.	14.7	17.3
Average production per payroll man-shift, raw coal	do.	11.9	13.6

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 15:01 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 13

Coal bed		Pittsburgh
Thickness of bed	inches	96
Thickness mined	do.	84

		Mobile loading	
		Double unit Entries	Single unit Entries
Percent of mine production		47.1	52.9
Hours per shift		8	8
Number of units		1	1
Unit shifts per day		3	6
Average yield of clean coal	percent	93	93
Average width of place	feet	16	16
Number of places in set		8	8
Average advance of working place per shift	feet	16.2	-
Average advance of working place, including crosscuts, per shift	do.	21.3	-
Employees:			
In unit crews		57	72
Supervisory and other underground 1/		44	49
Total underground		101	121
Surface 1/		16	17
Total charged to		117	138
Average daily production, raw coal	tons	2,244	2,520
Average production per unit per shift, raw coal	do.	748	420
Average production per man-shift in unit crew, raw coal	do.	39.4	35.0
Average production per underground man-shift, raw coal	do.	22.2	20.8
Average production per payroll man-shift, raw coal	do.	19.2	18.3

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 14:51 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Summary, Mine 14

Coal bed ..... Pittsburgh

Thickness of bed ..... inches 96

Thickness mined ..... do. 84

	Mobile loading	
	Double unit Entries	Single unit Entries
Percent of mine production	75.6	24.4
Hours per shift	8	8
Number of units	2	1
Unit shifts per day	6	3
Average yield of clean coal ..... percent	85	85
Average width of place ..... feet	16	16
Number of places in set	10	5
Average advance of working place per shift ..... feet	13.1	-
Average advance of working place, including crosscuts, per shift ..... do.	17.1	-
Employees:		
In unit crews	126	42
Supervisory and other underground[1/]	67	22
Total underground	193	64
Surface[1/]	38	12
Total charged to	231	76
Average daily production, raw coal ..... tons	5,340	1,719
Average production per unit per shift, raw coal ..... do.	890	573
Average production per man-shift in unit crew, raw coal ..... do.	42.4	40.9
Average production per underground man-shift, raw coal. do.	27.7	26.9
Average production per payroll man-shift, raw coal .... do.	23.1	22.6

1/ Number of men prorated in proportion to average daily production.

Generated on 2024-09-21 15:03 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

APPENDIX II

Previous Publications in the Series

TOENGES, A. L., and ANDERSON, R. L., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 1: Bureau of Mines Inf. Circ. 7014, 1938, 56 pp.

TOENGES, A. L., and JONES, F. A., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 2: Bureau of Mines Inf. Circ. 7067, 1939, 58 pp.

TOENGES, A. L., and MAIZE, E. R., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 3: Bureau of Mines Inf. Circ. 7178, 1941, 43 pp.

TOENGES, A. L., MAIZE, E. R., and JONES, F. A., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 4: Extraction of Pillars With Mechanized Equipment: Bureau of Mines Inf. Circ. 7223, 1942, 59 pp.

TURNBULL, L. A., and TOENGES, A. L., Mechanical Mining in Some Bituminous Coal Mines. Progress Report 5: Extraction of Pillars With Mechanized Equipment: Bureau of Mines Inf. Circ. 7527, 1949, 59 pp.

HALEY, W. A., SHIELDS, J. J., TOENGES, A. L., and TURNBULL, L. A., Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 6: Extraction of Pillars With Mechanized Equipment: Bureau of Mines Inf. Circ. 7631, 1952, 64 pp.

SHIELDS, J. J., MAGNUSON, M. O., HALEY, W. A., and DOWD, J. J., Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 7: Methods of Mining With Continuous-Mining Machines: Bureau of Mines Inf. Circ. 7696, 1954, 118 pp.

INT.-BU.OF MINES,PGH.,PA. 879

Generated on 2024-09-21 14:52 GMT / https://hdl.handle.net/2027/osu.32435030643498
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY